Food and Agriculture Organization of the United Nations

STATE OF THE WORLD'S FORESTS

FORESTS *for* KIDS

TEACHING GUIDE
(age 8–13)

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Food and Agriculture Organization
of the United Nations
Rome, 2017

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Introduction

HELPING YOUTH TO UNDERSTAND FORESTS AND CONTRIBUTE TO THEIR FUTURE

Forests and trees provide security and well-being for hundreds of millions of people, as crucial sources of **food, energy and income**. They also stabilize **soils and climate**, regulate **water** flows, and give shade and **shelter**. **They are home to an estimated 80 percent of the world's biodiversity**, including pollinators and natural predators of agricultural pests.

Although the annual rate of global **forest loss has slowed, deforestation remains a matter of concern**. Forest is still being lost, in the tropics in particular, mainly due to agriculture.

It is possible to halt deforestation while achieving sustainable agriculture and food security, as examples worldwide have shown. But concrete action is required to ensure that forests and agriculture are managed **sustainably** and in an **integrated** way. Today's youth need to know that it is not necessary to destroy forests to produce more food, and to understand the myriad ways in which forests contribute to food security and other basic human needs. If they are managed properly, they can be used without ever being used up.

These educational materials are based on FAO's report *State of the World's Forests 2016 – Forests and agriculture: land use challenges and opportunities*, as well as other relevant publications. They aim to provide **students aged 8–13** with a broad introduction to forests, their current state, and what can be done to look after them, while allowing teachers to meet **curricular objectives** efficiently.

AN ACTIVE AND EFFECTIVE PEDAGOGICAL APPROACH

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School children planting trees, Republic of Korea.

The teaching plan is **student-driven**, rich in **active sessions using investigation and experimentation**, and draws inspiration from internationally recognized approaches such as the enquiry method.

Learning takes place **in classrooms and under the trees**. Teachers receive **practical tips** to help them conduct activities in a safe and effective way.

It is possible to carry out the teaching in the classroom only, but it is our aim to convince all teachers they can take children into the forest or to areas with trees to get a feel for the environment, with less effort than they might have imagined.

International Day of Forests, Kanchanaburi, Thailand

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Camp organized by Kids-2-Forests, Kanchanaburi, Thailand

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Working together in Kenya

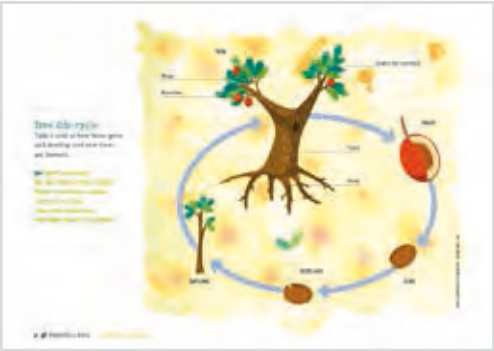
This content has been designed **by teachers for teachers**. It is meant to be directly applicable for work in class, with a practical but not overly didactic approach.

Content can also be **customized**. Teachers can select the activities of most relevance to their needs, build their own modules over time, and adapt to local contexts as they see fit.

Teaching about the sustainable **management of forests** may be important but not yet a part of your national or local **curriculum requirements**. The present modules strive to tie in with traditional curriculum design.

The approach is **transdisciplinary** but each module focuses more specifically on one disciplinary area, to allow for more targeted learning.

Most learning will correspond to **science** (first three modules) or **geography** (4th module) subjects, but **language** and **collaboration** are also at the core of many lessons.



WHAT YOU WILL FIND HERE:

- **Four teaching modules:** the first defines forests, the second investigates how they are key in the water cycle, the third explores non-wood forest products, and the fourth and final module provides students with insight into how to manage forests, e.g. via role play. Each module includes objectives, a teaching plan, a few likely student misconceptions, background information for the teacher's own documentation, teaching tips, the rationale behind activities, detailed notes for in-class facilitation of each session, and references.
- **A quiz** to take stock of the learning.

Students will find documentation to back up the learning activities in a dedicated **learning guide**, which complements the teachers' manual.

All of these elements will also be made available on a **website**, including the quiz in an interactive format. The website will be developed in due course to provide more interactive features.

WHAT YOU WILL NOT FIND HERE

These teaching materials are **designed to be an introduction**. Not all relevant forest-related topics have been included. Important aspects may be added in future editions, for example, concerning wood and wood products and sustainable forest management including forest harvesting, wildlife, forest soils and forests as habitats.

The materials cater to **diverse target audiences**, and teaching can be adapted for children from primary school to middle school. It should also be noted that not only will students' age vary, but also their culture, bearing in mind that this content is not based on a specific country's curriculum. This means that some practical aspects have to remain flexible. Sessions are planned to last from 30 to 45 minutes, but this will vary based on age and local context. For example, time planned to wash hands after touching plants is not the same if you have several sinks in the classroom or just one for the whole school. Teachers are encouraged to make this document theirs and change lessons to suit their needs.

Your feedback is welcome, and a feedback form is included at the end of the present document to help us improve this material for future versions.

MODULE 1

What is a forest?

I. Summary

This module helps students to understand forests as ecosystems in which all elements interdepend. It shows that forests are organized in layers, made up of trees, plants and many other organisms. Students also learn that forests change, including due to human activities. The module then provides perspectives on the importance of these complex ecosystems and engages students to act to look after and safeguard forests for the future. It includes class activities as well as outdoor learning, with tips on how to structure and conduct work safely.

II. Subject areas, objectives

- Subjects: science; language; geography; interpersonal skills and citizenship.
- Cognitive learning outcomes: forest layers; food webs; forest ecosystem diversity; plant growth.
- Methodological learning outcomes: carrying out measurements; creating models; reasoning and critical thinking.
- Social/interpersonal impact: collaboration; applying knowledge to action for sustainable development.

III. Teaching plan

Session 1:	**What is a forest?** Question transfer. Students' conceptions. Visit preparation. Summing up. *45 min.*
Session 2:	**Forest or outdoor visit.** Discovering a site. Question reminder. Collecting and measuring. Drawing layers. Cleaning and summing up. *Approx. 2 h.*
Session(s) 2b (optional):	**Sowing tree seeds.** Class plantation over at least 2 weeks.
Session 3:	**Organizing collection.** Question reminder. Sorting collected material. Structuring vertically. Summing up. *45 min.*
Session 4:	**Are these forests?** Question reminder. Landscape zoning with tracing paper. Study of layers. Recording of results. *45 min.*
Session 4b (optional):	**Back outdoors to study diversity.** Checking forest layers. Tree diversity inventory. *Approx. 2 h.*
Session 5:	**Tree study.** Sorting leaves. Identifying a leaf/tree. Life cycle document study. Summing up. *45 min.*
Session 6:	**Connections and interactions.** Question. Yarn food web. Needs mind map. Summing up. *45 min.*
Session 7:	**Are forests always the same?** Defining question. Forest pictures in time. Local case study. Conclusion. *45 min.*

(continued)

(Continued) Teaching plan
Session 8: **Conclusions.** Value of trees/forests. Importance of assessing their evolution. Final summary. *45 min.*
Session 9: **What do we do now?** Knowledge reminder. Brainstorm. Action design. *45 min.*
Implementing action: Post-module, based on the action chosen in class.

IV. Possible student misconceptions

Student misconceptions	*Possible answers (experiments they could imagine and are worth testing; other ways to answer)*
If there are several trees, it's a forest (park, orchard, ...).	Session 4 (p. 6) addresses this.
Real forests are entirely natural.	Session 7 (p. 9) addresses this.
Only fully natural forests are of value because they are more diverse.	Optional Session 4b (p. 7) addresses this.
Diversity is only a matter of animals (possibly of big mammals).	This module addresses this.
Forests always are and were the same.	Session 7 (p. 9) addresses this.

V. Background and focus on key issues

ISSUE 1: FORESTS ARE COMPLEX SYSTEMS, WHICH MAKES THEIR DEFINITION COMPLEX

Forests represent one-third of the world's land area and host more than half of the world's plant and animal species. They are not easily demarcated, and they change over time: the total surface area of forests worldwide is decreasing, although recently the rate of forest loss has been slowing globally.

Forests are systems (ecosystems), where the living biome (plants, animals, fungi, lichens, micro-organisms) and abiotic elements (water, light, temperatures, wind, etc.) interact. They are impacted by their wider ecological context, soil composition, seasons, water modifications (e.g. floods), disease and pests, and have historically been shaped by human activities.

Forests are also communities, where all living beings interdepend via food webs, based on green plants – the primary producers of organic matter (whereas other living beings are consumers or decomposers). Food webs are not the only way living beings interconnect. For example, trees also provide a habitat for animal and bird species.

Forest types can be classified according to their biome type, including tropical dry forests, subtropical dry forest, tropical rainforests, temperate broadleaved deciduous forests, mountain forests, mangrove forests and boreal coniferous forests.

Part of the mandate of the Food and Agriculture Organization of the United Nations (FAO) covers forests and forest management. FAO defines forests as land with trees more than 5 m in height and a minimum canopy cover of 10 percent, excluding land that is mainly used for agriculture or urban development. This includes both natural and planted forests. Although this definition excludes urban areas, trees growing in towns or cities may also be considered as forming a type of forest ecosystem.

ISSUE 2: AVOIDING OVERSIMPLIFICATIONS ABOUT NATURAL FORESTS AND DIVERSITY

The balance between living tree populations in forests is not stable; their biodiversity is complex and reflects both species diversity (richness) and relative numbers of individuals for each species (evenness). Variation between individuals of the same species matters just as much; it is a result of genetic variability, which is important for adaptation to changes over space and time. As nature selects trees (and other organisms) based on

their genetic variation, local populations that are isolated from each other tend to differ, hence the need for local species conservation.

Lower levels of diversity do not necessarily imply less value: both natural and planted forests with low diversity exist and provide numerous goods and services, including protection of soil and habitats for wildlife. The level of diversity is meaningful in relation to expectations for a given forest.

Many forests are managed to some extent by humans. If a person can walk around easily, forest floor vegetation has probably been managed. Human impact on forests is ancient – for example, in the Mediterranean region, traces of human fires in forests date from prehistorical times. Current human impacts on forests relate to land-use choices (agriculture versus forest), product demands, recreational use, fire protection measures and more.

ISSUE 3: CHOICE OF APPROACH

Because of forests' magnitude and complexity, choices must be made in terms of scale and approach.

Studies of forests have moved from a descriptive approach (e.g. differentiating species by their aspect) to functional analysis ("How does it work?"). Studying forests based on their layers allows students to go from description ("I see layers") to functions: Layers provide for ecological diversity (different layer combinations will lead to different forest ecosystems). Layers can be classified in various ways, with from three to as many as ten layers. A convenient categorization contains the following: forest floor (litter), understorey (forbs, grass and shrubs, which differ from young trees by their multiple stems), emergent layer and canopy. Animals and vegetation may move across layers over time, as trees do when they mature.

Trees differ from most other plants by their perennial (long-lived) woody stem. They can be classified as deciduous species, which lose their leaves seasonally, or as evergreen. They grow in height thanks to vegetative buds (not to be confused with reproductive flower buds). Trees also grow in diameter (with growth taking place in the cambium, found in the layer just under the bark). Some tree species have visible rings that facilitate the study of their growth, as they represent the inner living layers under the bark that have aged and become inactive. These growth rings reflect seasonal changes (including changes in climate).

Wood refers to the tree's secondary xylem, i.e. the cells that have aged and hardened, thereby becoming a rigid structure that supports the tree and hosts its nutritive transport system.

To understand the reproduction of trees, we can study flowering and seed production. The processes involved, which differ among tree species, determine occurrence, growth, and place and role of a given species in forest ecosystems. Pollen is spread by wind, or at times by insects or animals such as bats or possums; seeds may also be transported by wind or water, or depend on animals for their dissemination.

VI. Notes on pedagogical approach and class animation

1. SAFETY AND ORGANIZATION TIPS

Although nature visits are not intrinsically dangerous, many teachers have legitimate concerns about working outdoors with students. Will the students get out of control? What if someone gets lost? Does real learning take place or will it just be seen by students as an excuse to leave the classroom? It can also be seen as considerable extra work for teachers.

This section lists practical tips, aimed at complementing the tools already provided by your local school institution and/or forest authorities (e.g. security checklists, consent forms). Most of these tips relate to preparation – as forethought and planning are key to success. There is therefore extra preparatory work, which can be considered a reusable investment.

Rehearse: If you worry about students' behaviour, rehearse in class, so that the novelty will only be the location itself. Once behavioural expectations are established (see Session 1, below), you can rehearse them on school grounds or somewhere nearby. You may even choose to conduct the entire session there.

Get help: Invite others – such as community workers, parents and specialists – to participate, to ensure that any legal requirements for a specific adult /child ratio is met. Prepare helpers to facilitate learning activities while ensuring that safety needs are also met. Research the area you are planning to visit. If possible, go there with the helpers, and assess/ remove possible risks (e.g. broken glass, poisonous plants/fungi, deadwood…). While there, discussing emotions may help raise confidence levels – e.g. does the presence of nature all around you help you focus, feel grounded?

Choose the right location: Relocate if the terrain is too steep or near deep water. Plan marked working spaces for observation/group work. Select an "outdoor classroom" spot, if possible sheltered, where instructions can be given and quiet work can take place. If relevant, find an area for snacking and play… Also check that the space is safe and hygienic.

Plan for risks and hazards such as travel hazards, bad weather, animals and plants (e.g. if ingested) and make appropriate provisions (e.g. medicines). Have an alternative plan in case the weather changes. Make a note of rescue services' contact details, if any. Make sure you have a backup person at school with parent information during the activities; helpers also need to be given the necessary contact information.

Set expectations, such as no running unless in designated specific areas; no throwing; only adults with gloves will pick up rubbish or glass; no sticks above shoulder height; no touching of stinging, sharp or poisonous plants; make sure students know what is expected in terms of toilet needs.

Prepare material and equipment: Check students' equipment and clothing. Bring a whistle, first aid kit, insect repellent, and sunscreen, litter bags and water for basic hygiene if needed. Fully charge mobile phones. Consider getting students to make a disposable "cushion" (see Session 1, p. 5).

Once there: Be particularly attentive at the beginning and end of activities. Upon arrival, check any risks that might be present again (e.g. high wind, hanging deadwood), establish physical and behavioural boundaries, remind students about safety and hygiene procedures. Make sure that you are in sight or earshot of all students. Arrange for students to wash their hands after touching plants or forest litter.

2. TEACHING APPROACH

Module design draws on studies showing that the key to quality outdoor learning include early and well-prepared visits. Teaching spans cognitive as well as emotional and social aspects of learning. Students are active. They work as a class, in groups and individually.

3. NOTES FOR ANIMATING EACH SESSION

SESSION 1. WHAT IS A FOREST? LAUNCHING WORK, PREPARING VISIT

Session 1: **What is a forest?** Question transfer. Students' conceptions. Visit preparation. Summing up. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Question transfer: What is a forest? Question and project introduction. Optional reading of literature/story on forests.	5–10 min.	Whole class	Poster paper and marker pens
Students' vision of forests: brainstorm (word forest or mind map poster), including emotions so that fear is mentioned if it is present. Students draw a forest and what they expect to see there.	15 min.	Whole class, then individual work	Experimentation notebook/pencil for drawings

(continued)

(Continued) Session 1			
Session focus	***Timeframe***	***Organization***	***What you will need***
Preparing the visit: Students list, e.g. • scientific equipment • clothing and personal equipment (bags...) • security (aid kit...) • behaviour rules... ***Option:*** making a "cushion" to sit upon.	20 min.	In groups (2–4)	Experiment notebook *Option:* tape and folded newspapers to make "cushion".
Summing up: Completing lists.	5 mn.	Whole class	

SESSION 2. FOREST OR OUTDOOR VISIT. DRAWING LAYERS AND COLLECTING SPECIMENS

Consider "collecting" specimens through pictures to minimize disturbance. Possibly only adults should take living samples (note the "1 in 20" rule e.g. collecting a plant only if over 20 of the same grow nearby). Leaves, cones and non-living specimens contribute to ecosystems and should be collected in moderation (e.g. for making casts, leaf rubbing).

Note that there is no need to explain or name forest layers in this session.

Session 2: **Forest or outdoor visit.** Discovering site. Question reminder. Collecting and measuring. Drawing layers. Cleaning and summing up. *About 2 hours (more if setting shifts between work stations).*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Discovering the site: Highlight entrance into the forest; check safety; establish physical and behavioural boundaries, remind about safety and hygiene procedures.	15 min.	Whole class	Boundaries marker (flagging, cones, ribbons...)
Activity 1: Collecting and measuring Question reminder, task definition. Groups "collect" specimens from different layers. The ground layer group can turn a log over; it collects at least three types of leaves. Groups working on higher layers can measure (e.g. how tall plants are) including abiotic elements (where temperature is higher, where it is lighter or darker...) as well as "collect" species, e.g. trees. The canopy layer group can shake a branch over a white sheet and "collect" what falls. Make sure at least one group identifies a specimen that is present across different layers (e.g. bird, vines...). ***Optional:*** Wildlife tracking (e.g. moulding ground tracks). Activity can be adapted to village/urban context, e.g. tree and or insect inventory of schoolyard/ school block.	30–45 min.	Groups of 4–6 at different work stations (with some individual work in the group), each station focusing on a layer Preferably with one adult per group	Clipboard (e.g. erasable slate with peg), pencils, white paper (possibly divide/ fold sheets for a sense of scale) ***Optional:*** camera, measuring tape, thermometer, lux meter, compass, magnifying glass/ bug box, white sheet, field guides (plants, animals...), material for plaster cast...
Activity 2: Forest layers ***Task definition:*** Drawing forest landscape in notebook and detailing a part ("How can we separate parts?"). Each group details a layer (without naming the layers). Detailed drawings (including birds, sunlight, shade, water...), but only drawing what is actually seen. Optional workstations for early finishers e.g. "listening workstation", sensorial station, land art station...	20 min.	Individual work within groups of 4–6 at different work stations	Clipboard, pencils, experiment notebook in a zip lock bag, "cushions" if any
Cleaning of work stations, hands...	5–10 min.	Whole class or groups	
Summing up: Is the forest as expected? What might a forest be?	10 min.	Whole class	"Cushions" if any

OPTIONAL SESSION(S) 2B. SOWING TREE SEEDS

This can prepare for Session 5 (tree growth, p. 8) and help reinforce the idea that trees are plants. Seedlings can be used to prepare Module 2, Forests and water (p. 13).

Session(s)2b (optional): **Sowing tree seeds.** *Class sowing exercise over at least 2 weeks.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Sowing tree seeds in class ***Optional:*** Hypotheses on seeds' needs with comparative planting	Over 2 weeks	Context-based	Tree seeds, gathered in forest or not, e.g. avocado, acorns... Mould/cast Flower pots Optional other pots (e.g. rocks, water...) for comparative sowing

SESSION 3: ORGANIZING COLLECTION – BIO/ABIOTIC AND VERTICAL STRUCTURE

Students may identify categories such as plants, insects and birds when sorting collected material – and not think of vertical organization. This is not a problem. Inform students that such categories do lead to valuable science (taxonomy), but do not really help answer our question...

Session 3: **Organizing collection.** Question reminder. Sorting collected material. Structuring vertically. Summing up. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question reminder. Task definition: organizing information collected so as to define a forest.	10 min.	Whole class	Experiment notebook
Sorting collected material: Students groups get 8–10 pictures, decide how to sort and name picture sets, first in two categories (at least one group should come up with living/non-living; one group might come up with ground/higher). Name categories. Sum up, discuss. Then repeat exercise in four categories (or as many layers as there are in the structure but without explaining this in so many words). Name categories. Sum up, discuss.	15 min.	In groups (2–4)	8–10 labelled pictures of species per group (at least two animal and plant species and two abiotic elements, with two from each layer): photocopies of students' forest drawings Pen/experiment notebook to write names of categories
Structuring vertically: Groups discuss where their pictures should be on the poster. Group deputies come and stick their group drawings on the class forest poster. Discuss choices (write names of layers if any is named)? Could any species go elsewhere (relocate on poster) and why?	10 min.	Same groups (4–6) as during outdoor visit	Photocopies of students' drawings, labelled; white paper poster; dough to fix
Summing up: Drafting class's hypothetic definition of forest (living and abiotic elements, diversity of species, vertical structure). Are you sure this is what a forest is? Are all forests like this?	10 min.	Whole class	Poster or black/white board Experiment notebook

SESSION 4: ARE THESE FORESTS?
GENERALIZING ABOUT LAYERS FOR ALL FORESTS, FORMALIZING THEM

Students finally learn explicitly about layers. Pictures selected in the Learning guide (pp. 4–6) aim to provide different difficulty levels (differentiating a desert from a forest is easier than for example differentiating a forest from an orchard). Choose according to class context.

Session 4: **Are these forests?** Question reminder. Landscape zoning with tracing paper. Layer study. Recording of results. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question reminder. Task definition.	5 min.	Whole class	
Students delimit zones/parts of landscapes using tracing paper, and give them a title (landscape name). ***Discussion:*** • Display traced landscapes, hiding titles (folding): Are they all forests? Why/why not? • Group forests: what is the same?	15 min.	Individual	Pictures of types of forest and a few non forest landscapes (see Learning guide, pp. 4–6) Tracing paper Pencils Dough to fix
Studying a layer: • Task description • Group document study • Groups choose a way to report to the class about their layer (e.g. drawing, text posters, mime...) and prepare • Group report	15–20 min.	Groups of 3–4	Documents on each layer, pictures or text (see Learning guide, pp. 4–7)
Recording of results regarding layers: • Labelling and colouring diagram of forest layers. • Discussion: What would happen if layers disappeared? • Summary: Layers define forests, provide for diversity. ***Optional:*** • Venn diagram: which species in which layer (trees at the centre) • Moving species on class poster through layers in time (e.g. day and night) • Diorama in a shoe box • Concrete poem from an element from each layer	10 min.	Whole class and individual	Notebook Copies of forest layer diagram (see Learning guide, p. 7) Colour pencils Glue

SESSION 4B (OPTIONAL): BACK OUTDOORS TO STUDY DIVERSITY – TREE INVENTORY AND COMPARISON

Session 4b: **Back outdoors to study diversity.** Checking forest layers. Tree diversity inventory. *About 2 hours.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Check forest layers: if any missing, why (e.g. human action)? List signs of wildlife in each layer. Draw details of layers on diagram and name layers. ***Tree diversity inventory:*** fill in Table 1A (Learning guide, p. 12) while working on plots of 85 × 85 cm. Locate trees bigger than 5 cm in diameter when measured at a height of 1.3 metres (adapt these criteria for the exercise if necessary) and identify tree species. ***Compare:*** • results of different groups; • information between different types of forests. ***Discuss diversity:*** What would happen if all forests were of one type (only planted, only mixed...). ***Optional:*** Soil study (to span functional diversity: recycling nutrients). ***Alternative:*** Conduct this visit in a local park, school yard, orchard (are there layers, is it a forest?).	2 hours	Groups of 2–4	In a zip lock bag: Clipboards Copies of Tables 1A–3A in Learning guide (pp. 12–13) Measuring tape Pencils "Cushions" if any

SESSION 5. TREE STUDY. IDENTIFICATION AND GROWTH

Session 5: **Tree study.** Sorting leaves. Identifying a leaf/tree. Life cycle document study. Summing up. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Context reminder (dominant forest plant). Task definition.	5 min.	Whole class	
Sorting leaves: Students explain/write their sorting criteria	10 min.	In pairs	Leaves collected from the class's outdoor visit (drawn copies if needed) Experiment notebook
Identifying a leaf and its tree: Documentation study and writing tree ID cards: tree name, maximum age, how fast they grow, guessed age of sample (in which layer did we see them in the forest?), shade tolerance... Illustration of card ***Optional:*** • Specific work based on class sowing of tree seeds (see Session 2b) • Tree ring study outdoors or in class (sample, picture...) • Seed game: Students crouch in a hoop and must reach cards representing their needs to grow into a tree (alternative: class creates illustrated dice or board game on seeds' requirements in order to grow)	15–20 min.	In pairs	Tree ID key existing local source or self-made Documents on local tree species Leaf and glue
Life cycle of a tree: Student study documentation on tree life cycle and answer questions. ***Summary:*** • Display "ID cards" for various tree species • Were trees always in the same layers in which we saw them? • Trees are plants that dominate forest layers and are present in all of them. Brief description of their life cycle.	15 min.	In pairs	Diagram in Learning guide (p. 8)

SESSION 6: CONNECTIONS AND INTERACTIONS, FROM FOOD TO NEEDS

FFood web modelling difficulty: if students move a lot or drop their piece of yarn (see below), the web is gone. If so, stop the activity, sit and discuss: What would happen in nature if a part of the web went missing, or moved elsewhere...?

Brainstorming ecosystem connection difficulties related to elements other than food: Use class posters and notebooks as reminders about habitat and abiotic elements noted outdoors.

Session 6: **Connections and interactions.** Question. Yarn food web. Needs mind map. Summing up. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Question: What connects elements of the forest? (Or: Can elements of a forest exist without one another?). Hypothesis (likely first idea: food). Food chain ***Introduction:*** what do you eat, what does it eat, etc. Task definition.	10 min.	Whole class	Experiment notebook to list "elements" (living and abiotic)

(continued)

(Continued) Session 6

Session focus	*Timeframe*	*Organization*	*What you will need*
Connecting specimens – web modelling: Students tape species label to their chests and form a circle standing still within hoops. Sun stands in the centre, holds end of the yarn tightly, choses who to give energy to ("Who can eat me?"), and tosses the ball. Green plant catches ball of yarn, holds a piece tightly and throws ball again... When yarn reaches a carnivore, cut it off (one food chain). Return ball to the sun and start new chain; repeat until every student holds a strand of yarn. ***Sit and sum up:*** Who has more yarn? Why?	10–15 min.	Entire class or half class	Labels of species in food web plus sun Tape Ball of yarn Hoops to help students stand in place Scissors Open space (no tables, etc.)
Class brainstorm/mind map of needs: Interconnect elements of the forest beyond food (note importance of sun in modelling) ***Written summary:*** forests are ecosystems interconnected by needs, and include non-living things. Trees are at the centre (producers).	10 min.	Whole class	Poster paper, marker pens *Optional:* notebook

SESSION 7: ARE FORESTS ALWAYS THE SAME? HUMAN IMPACT AND OTHER CHANGE FACTORS

When asked if forests change, students might think along the lines of a daily time frame. Explore this and then widen to the scale of the tree's life.

Students may not understand the value of forests other than for wood. Wood is not covered as a theme within the present material as other modules will address it. However, if you do not plan on using the other modules, spend time to help students brainstorm about key benefits of forests other than wood (water, carbon storage, soil stability, biodiversity, non-wood products...).

If students cannot think of non-human change factors, use a poster or notes from the outdoor visit and results from optional comparative sowing of tree seeds.

Session 7: **Are forests always the same?** Defining question. Comparing forest pictures in time. Local case study. Conclusion. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Defining question: Does a given forest always look the same; what makes forests change? Brainstorm hypotheses.	5 min.	Whole class	Poster or black/white board
Observation of forest maps/pictures over time: • Describe change/evolution between photo A and B. • Write hypothesis as to why. ***Discussion:*** What did you find? What's the use of forests? Brainstorm about the usage of wood.	15–20 min.	Individual then whole class	Maps and photos Learning guide, p. 10
What made our forest change? ***Local case study:*** • Document study, e.g. comparing different stages of a local forest in time. • Hypothesis on change factors. • Document study on factors. ***Optional:*** Students make a timeline poster of the local forest species, showing change over time...	15–20 min.	Whole class	If possible: local historical forest map/ pictures. Testimony from forest officer, newspaper article (e.g. on fire, pests...)
Mind map: What else can make forests change? (soil, water availability, climate, natural development (succession)...). ***Summing up:*** Forests as living, changing organisms; human impact on forest.	10 min.	Whole class	Class material Notebook *Optional:* results from comparative sowing of tree seeds

SESSION 8. CONCLUSIONS. THE VALUE OF TREES, THE IMPORTANCE OF ASSESSING ANY CHANGES, THEIR DEFINITION

Session 8: **Concluding on the value of trees.** Value of trees/forests. Importance of assessing change. Final summary. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Can we calculate or assess the value of a tree/a forest? ***Groups brainstorm;*** Secretary takes notes about the value of forests on sheets of paper. ***Class discussion:*** Group reporters display and explain the group sheet; class organizes and groups the sheets together by theme/type of value. ***Optional:*** Calculate the value of a tree using the online USDA National tree benefit calculator.	15 min.	Groups of 2–4 and whole class	Sheets of paper and marker pens Dough to fix *Optional:* computers connected to the Internet
Is it important to assess and manage forest change? Why? Class brainstorm. ***Document study:*** Read text about FAO Global Forest Resources Assessments and State of the World's Forests 2016. Class discusses meaning of these	15 min.	Whole class then individual	Text document Learning guide, p. 11
Writing final summary: Definition of forests (ecosystems dominated by trees and including plant and animal life, inter-related with abiotic elements); importance of forests, each with their specific level of diversity. ***Optional final activity:*** the class creates a game e.g. "happy families" cards, where the player gathers all the elements together of a forest ecosystem and families are types of forest (e.g. "In the tropical forest family, I need an "xxx", which is an abiotic element").	15 min.	Whole class	Notebook

SESSION 9: WHAT DO WE DO NOW? RECALLING KNOWLEDGE ACQUIRED

Session 9: **What do we do now? Forests are ours.** Knowledge reminder. Brainstorm. Action design. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Knowledge reminder (importance of forests, impact factors). *Possible triggers:* threats to the local ecosystem, news story about threats to animal/human life in a given forest ecosystem...	10 min.	Whole class	Class posters, experiment notebook
Groups brainstorm action, e.g. communicate with other school children (display, game); correspond with a forest school class; get involved in national forest programmes, if any; remove garbage; identify and remove non-native species if harmful to the native ecosystem (with the approval of the forest's owners/caretakers); perform trail maintenance; plant native trees; "adopt" a forest lot ... Class chooses action.	15 min.	Groups of 2–4	Optional: experiment notebook
Action design: how, when, what is needed, starting to write documents...	20 min.	In groups or pairs	Notebook

VII. Teaching extensions, in addition to the present module on forests

Art; animal biology (e.g. terrarium, keeping bugs...); prehistory; geology.

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MODULE 2

Forests and water

I. Summary

This module introduces students to the value of forests for the Earth's water. It uses the "enquiry" (or "investigation") teaching approach to help them understand the path of water in a tree, and the way that trees and forest ecosystems act as water redistribution systems. It concludes with a document study to help them understand other aspects of the crucial role of forests with regard to water (prevention of waterlogging, preservation of soil humidity and water quality) and the hydrological cycle. This module can be conducted entirely in class.

II. Subject areas, objectives

- Science; language; social sciences; interpersonal skills and citizenship.
- Cognitive learning outcomes: basic understanding of the ecological role of forests with respect to water through: plant transpiration; aspects of the three stages of water (two treated here: liquid and vapour); aspects of the water cycle.
- Methodological learning outcomes: basic understanding of the process of scientific reasoning and of experimentation variables.
- Social/interpersonal impact: interpersonal skills (collaboration); being able to apply knowledge to action for sustainable development – specifically related to forests.

III. Teaching plan

Part 1: **Path of water in and out of plants – trees as water redistribution systems**	
Preparation of question *(optional)*, based on class context (e.g. plant growing activities with measurement of water intake...).	
Session 1:	**Where does water go when we water plants?** Defining the question. Hypothesis. Notes and diagram. Summing up. *45 min.*
Session 2:	**Experiment design.** Question reminder. Design of experiment(s). Notes and diagram. Discussion. *45 min.*
Session 3:	**Experiment – plastic bag around leaves, coloured water...** Question reminder. Experiments. Notes and diagram. Summing up *45 min.*
Session 3b *(optional)*:	**Details of the path of water in the plant: root hairs** – water and oil experiment. *45 min.*

(continued)

(Continued) Teaching plan
Session 3c *(optional)*: **Details of the path of water in the plant: from root hairs to xylem**– document study. Water and paper tube experiment. *45min.*
Session 4: **Conclusion, findings**. Process reminder. Document study. Result analysis, expanding to forests. Lesson. *45 min.*
Part 2: **Other aspects of forests' water-related values**
Session 5: **Water and soils:** Document study. *45 min.*
Session 6: **Water quality:** Document study. *30 min.*
Part 3: **Acting**
Session 7: **What do we do now? Forests are ours.** Knowledge reminder. Brainstorm. Action design. *45 min.*
Implementing action: Post-module, based on the action chosen in class.

IV. Possible student misconceptions

Prerequisites: The module requires understanding that trees are plants and that students' findings about plants can be applied to trees. Carrying out Module 1 of the present material (1. What is a forest? p. 1) will address this.

Student misconceptions	*Possible answers (experiments they could imagine and are worth testing; other ways to answer)*
Water does not go into the plant and evaporates.	Variant of main experiment: covering soil only.
Water goes into sewers.	Write to the local sewerage services (possible visit).
Water goes into the plant and stays there.	Invite them to elaborate until the idea no longer makes sense (how much water can it store, where, etc.).
Water dissolves into the plant.	Invite them to elaborate until the idea no longer makes sense – has it been reduced to non-existence or only vanished, etc.? Driving-at the notion of vapour (what could invisible water be?).
Water goes into the plant and is "peed".	Making them elaborate on where the excreted water might be found. Designing an experiment to find it depending on their answer (e.g. on the ground).
Leaves take in water (vs roots).	Variant of second experiment: applying dyed water to leaves.
Plants suck or actively aspire water from the ground.	Documentary study, see Session 3c of present module (p. 18).
Vapour is produced only when water boils. It is not invisible.	Session 3 and options might help deconstruct this. But specific class work on the three stages of water is needed, prior or subsequent to the present module.

V. Background and focus on key issues

ISSUE 1: A FOREST'S CONTRIBUTION TO THE EARTH'S WATER CYCLE IS NOT EASILY CAPTURED

Transpiration from plants occurs simultaneously with ground evaporation; both processes, which are not easily distinguished, are tagged under the same name, evapotranspiration. When the canopy is well developed, as in the case of forests, and most of the soil is covered, transpiration is the main process. This concerns trees and the understorey or ground vegetation, although at a lower rate due to the existence of shade.

Accounting for about 15 percent of the atmosphere's water vapour, evapotranspiration is not easily measured. As a world average, it accounts for some

65 percent of rainwater that goes back to the atmosphere, although figures differ widely across different regions and types of forest.

Although plant transpiration cannot be measured precisely, here are magnitude estimates: during a growing season, a leaf will transpire many times more water than its own weight; 1 m^2 of forest can contain over 1 000 m^2 of leaf surface area; an average tree evaporates several litres daily in active periods (e.g. from 900 to 1 515 l daily).

Vapour from a forest region may be higher than that of an equivalent water surface. Thus the basic water cycle diagram in which water is shown as evaporating from the ocean and then raining on land is oversimplified. This is all the more true as most oceanic moisture will fall as rain only within the first hundred kilometres from the coast; air is remoistened as it moves inland, notably thanks to tree transpiration, which thus plays a key role in preventing desertification

ISSUE 2: THE WATER TRANSPIRATION PROCESS ITSELF IS AFFECTED BY SEVERAL FACTORS

About 95 percent of water taken up by a plant is given to the atmosphere via transpiration. Water is mostly lost through stomata (pores situated predominantly on the under surface of leaves). The stomatal aperture controls and allows the exit of water as it evaporates, cooling the leaf, while allowing carbon dioxide (CO_2) entry for photosynthesis. When stomata are open, the transpiration rate increases. Transpiration is the plant equivalent of perspiration (sweating).

Environmental cues affect stomata: although stomata open in the light and close in the dark, they can close in the middle of the day, for example if CO_2 concentration is too high in the leaf (exceeding photosynthesis needs), or if the temperature is too hot and the plant lacks water, reacting in this case to the reduced water pressure. This is why it is said that plants can face situations where they can die either of thirst or hunger (when stomata open, plants will lose 500 g or 0.5 litres of water for 1 g of fixed CO_2).

Various kinds of plants may have different transpiration rates. Cool-season plant types, for example, have less stomatal control and therefore higher evapotranspiration rates. Plants with deep-reaching roots can transpire water more constantly (grown wheat roots can reach as far as a metre, tree roots to tens of metres), and woody plants tend to transpire more than herbaceous ones because of their more extensive foliage. Conifers can have a higher rate than deciduous forests, especially during the dormant season.

Trees from hot/dry climates tend to have fewer stomata and lighter colours to reduce transpiration, or else they turn their leaves to avoid direct sunlight. Trees from rainforests, however, have many stomata and are very green

Differences in plant/leaf anatomy as well as air temperature and humidity therefore affect transpiration – for example when temperatures rise, water loss may exceed intake, and leaves will curl because water is not sufficient to make them extend to their normal shape. Other factors include: wind; the soil's water content, including waterlogging and water salinity; the ability of the soil to conduct water; and albedo.

Note: in addition to closing their stomata, plants can also reduce water loss by developing thick cuticles, or by possessing leaf hairs.

ISSUE 3: PLANT TRANSPIRATION COMPONENTS CAN BE CONFUSED BY STUDENTS

Evaporation creates negative water vapour pressure (or suction) in the surrounding cells of the leaf – more water is then pulled in to replace transpired water. As tension builds up: the positive and negative electrically charged parts of the water molecules stick to one another in the xylem vascular tissue – first in the leaf and then through the rest of the xylem into the roots. The xylem, found under the bark, is thus roughly a continuous column extending from the leaf to the roots, passively transporting water. Finally, the negative water pressure that occurs in the roots will result in an increase of water uptake from the soil. But water is not just pulled in, it is also pushed up the root through capillary action (water tends to rise in a thin tube as it flows along the tube walls) and root pressure. Both push and pull pressure account for the force that transports water as high as 100 metres or more above the ground, as is the case in 0some high rainforest canopies. The xylem is composed of elongated dead cells with intact walls that serve as a pipeline. Xylem cells differ in size

and structure, for example in deciduous trees as opposed to conifers. Xylem should not be confused by students with the phloem tissue, also made of elongated cells but living and actively translocating nutrients and sugars.

Plant transpiration should not be confused with water exudation (drops of water on the leaf tip at the end of the night), which, unlike transpiration, does not have a heat regulation function and may be understood as a reaction to water pressure in the leaf: during the night, water pressure in plants rises and leaves spread wider, which will lead to better photosynthesis.

VI. Notes on pedagogical approach and class animation

1. SAFETY AND ORGANIZATION TIPS

Use seeds that have not been treated with chemicals.

Teach students to:

- wash their hands before and after touching plants;
- avoid touching their eyes when handling plants;
- not eat any part of a plant unless certain it is safe to do so.

See CLEAPSS, 2009 (Resources section, p. 22) for ideas of plants suitable for class. You may need to refer to different sources, depending on which region in the world you are teaching.

2. TEACHING APPROACH

This module uses enquiry-based teaching, an approach that seeks to engage students in activities that are meaningful for them, where they experiment and interact with the objects being studied, collaborate, think, exchange and write.

They follow a procedure similar to that of "real" scientists: question, hypothesis, experiment and/or observation, conclusion writing/communication of findings.

They take notes at each step of the process. Note-taking should be guided (e.g. "Can you take this idea further and write more about it…", "How did you come to this hypothesis?"…) but preferably not corrected (e.g. spelling): the notes are a work in progress, they help the student learn to reason scientifically. However, note-taking learning activities can be undertaken through language lesson sessions to facilitate this. Notes provide a key tool/help that should be used by students during the process (e.g. to check results, etc.) rather than seen as a teacher's requirement.

Experiment notes can be kept together in the same notebook with references/class findings and lessons but should be clearly separated from those notes visually.

Listen carefully to your students at all stages (possibly recording), as their comments can fuel the process and help move to the next step.

3.NOTES FOR ANIMATING EACH SESSION

SESSIONS 0. PREPARATION AND 1. WHERE DOES WATER GO WHEN WE WATER PLANTS? QUESTION TRANSFER, HYPOTHESIS

In enquiry learning, students own the question, and the teacher aims to find a way to help them formulate it. We will suggest a way below to get them there, but class context can lead you to find your own way to prepare and elicit the question, for example during the class visit to a forest or local park (see Module 1. What is a forest? p. 1), garden/farming activities/visit, previous classwork on plants or water…

Formulating the question is also student driven – while gardening, they might come up with "Where does all that water go?" rather than "What is the path of water in plants?" Guide them to formulate a question that is meaningful yet asked in their own words.

Optional preparation of question: **Plant growing.** *Over a few weeks.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Grow potplants of different sizes in class; the variable is the number of leaves and size; water them using bottles planted in soil; record water intake of each plant. Students need to record often enough that not all bottles are empty when they record – they should refill as soon as empty to record intake differences; teacher should thereby follow water levels and adapt the recording schedule. Each team of students notes the water intake for "their" plant. All students use the same recording table, created as a class and copied or glued in their experiment notebook, to note water given and when (the unit used should be standardized, e.g. 1 l for younger students).	10 min. each time At least 3 recordings (1–2 weeks)	Whenever plants need watering In teams of 2–4 students	Plants of same species but of different sizes (more/fewer leaves variable) Plastic bottles Ideally duplicated with a different plant species Experiment notebook

Session 1: **Where does water go when we water plants?** Question definition. Writing hypothesis. Summing up. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question transfer: Where does water go when we water plants? Adapt question transfer to class context. If students have carried out the optional preparation (see above) and the question has not come up spontaneously, you may ask them to write down total water intake in litres on a poster. Display posters, ask the students what they notice, guide them towards formulating the question. (*Note:* keep the posters on display in the classroom during the module).	10–15 min.	*Optional:* groups prepare posters; class discusses	Poster paper and marker pens (or as the class chooses in formulating the question)
Writing hypothesis, drawing diagram to illustrate hypothesis: Notes can be guided, e.g. giving the template: • Question: to be completed by student. • Hypothesis: I believe that water in plants goes... to be completed by student. • Diagram. Formalize collaboration as needed – each student must have a role (e.g. note-taker, diagram designer...)	20 min.	In pairs or groups (up to 4)	Experiment notebook
Summing up, discussing: Recalling the question. Grouping similar hypotheses. Making a poster of main class hypotheses. If reducing the number of hypotheses to be further investigated by class, it is best to not dismiss all hypotheses based on misconceptions, as some will lead to fruitful experiments.	10 min.	Whole class	Poster paper and marker pen

SESSION 2: EXPERIMENT DESIGN

Experiment design can be

- free, where students create experiments with no initial constraint. The teacher guides them towards relevance and feasibility with questions such as "Your hypothesis mentions that the heat of the sun is important / What can you use to replicate heat?" and comments;
- semi-guided (students can look at diverse materials/equipment placed on a table for inspiration) – this approach, suggested below, offers a good learning potential / feasibility ratio;

- strongly guided (each group receive only the materials/equipment needed). This last approach is less fruitful as learning is deeper when students use their misconceptions to design experiments that will ultimately dismiss those.

Session 2: **Experiment design.** Recalling the question. Experiment design. Notes and diagram. Discussion. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Recalling the question.	5 min.	Whole class	Experiment notebook
Design of the experiment(s); writing and drawing of diagram: Teacher asks each group questions and comments, so as to ensure that they all have a feasible, detailed plan that is sufficiently relevant to the question. Notes are prepared based on the following, to be included in a template: • description; • materials/equipment needed; • expected result; • diagram.	25 min.	Groups (2–4) with homogenous original hypotheses A display table with suggested experiment material	Three plants, rich in leaves; transparent plastic bags and rubber bands; ink and flowers/plants; experiment notebook
Summing up: Discussing, refining (e.g. variables) Several groups should ha ve come up with a similar experiment. At least one or two main class experiments are presented.	15 min.	Whole class	

SESSION 3: EXPERIMENT

Formalize roles if needed so that each student is active.

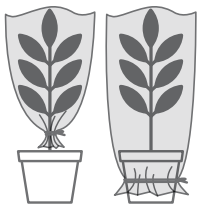
The experiment can and should be repeated. If results are very different from one experiment to the other, students should be guided to question causes The importance of using only one variable in experiments should be introduced.

Experiments can also be repeated, adjusting variables to deepen understanding, depending on class context. Here are some examples:

- Possible variant of the plastic bag experiment in the dark vs under light allows for linking the water path to photosynthesis for older students. Coating leaves with grease prepares for the introduction to stomata (variable: only the under part of leaves).
- Using a bowl instead of a bag allows for highlighting the micro-climate effect of palm trees in a very hot climate (when water transpired under the tree creates a fresher area around the trunk benefitting smaller plants).
- Transpiration can be assessed by weighing the plant at intervals, under the light vs in the dark (quick weight loss under light due to transpiration).
- Using a blow-drier on leaves allows assessment of the effect of heat on transpiration.

Session 3: **Experiment – plastic bag around leaves, coloured water...** *45 min.*
To be reproduced if failure, using variables etc.

Session focus	*Timeframe*	*Organization*	*What you will need*
Recalling the question and experiments, variables...	5–10min.	Whole class	Experiment notebook
Main experiment: Tying a plastic bag around the stems/leaves of plants. Notes: • if the bag was wrapped around the soil too, evaporated soil water would be added in the bag. • Make sure students do not think water in the bag is vapour (droplets as liquid). ***Second experiment:*** Soaking plant roots in dyed water. Carnations provide for visual impact but drive attention away from the leaves; celery is good for plant dissection; plants with translucent stems are also good... Other experiments based on students' ideas...	15–20 min.	Groups (2–4)	Three plants, rich in different leaf varieties; transparent plastic bags and rubber (repeated with another plant type if possible); ink and plant (e.g. carnation); other equipment based on students' experiment design.



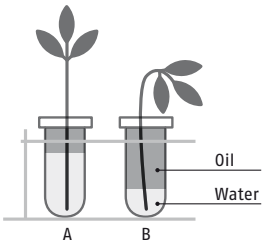
(continued)

(Continued) Session 3

Session focus	*Timeframe*	*Organization*	*What you will need*
Writing experiment description, drawing diagram.	15 min.	Whole class	Experiment notebook
Summing up: Reconnecting experiment to initial question (remind/guide so students notice the number of leaves variable). Experiment should lead to a related question, spontaneous or guided, depending on your choice of whether to move to step 4 directly ("Where does it go from there?") or undertake optional activities (e.g. "How does it enter into the plant?", "How does it climb up?"...).	10 min.	Whole class	Poster paper and marker pen
Main experiment (plastic bag) and second experiment (coloured water) follow-up: Write up elaboration of experiment. Teacher needs to follow this process and ask students to record it as needed. Provide a template for observation notes (e.g. for secondary experiment: time, how high colour is, completion of experiment diagram...).	10 min. regularly in the next 24–48 h	Groups (2–4)	Experiment notebook

Session 3b *(optional)*: **Details of the path of water in the plant: root hairs, water/oil experiment.** *45 min.*

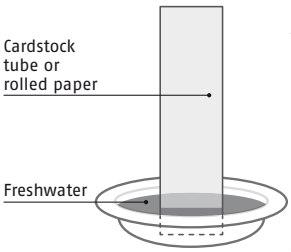
Session focus	*Timeframe*	*Organization*	*What you will need*
Recalling or giving the question and explaining experiment, variables...	10 min.	Whole class	Experiment notebook
Water/oil experiment: setting the plants so that root hair is either in water or oil (*variable*, only in water).	15 min.	Groups (2–4)	Tubes filled with water and a coat of oil, closed by a perforated cap; small plants with visible root hair
Writing experiment description, drawing diagram.	15 min.	Whole class	Experiment notebook
Summing up: Possibly defining next question, depending on whether you choose to move to step 4 directly ("Where does it go from there?") or undertake optional Session 3c (e.g. "How does it climb up?").	10 min.	Whole class	Experiment notebook
Experiment follow-up: writing up elaboration of experiment.	10 min. regularly in the next 24–48 h	Groups (2–4)	Experiment notebook



Session 3c *(optional)*: **Details of the path of water in the plant: from root hairs to xylem** – document study and water/paper tube experiment. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Recalling or giving the question, introducing document and explaining task...	5–10 min.	Whole class	Experiment notebook
Studying document. ***Optional:*** filling missing caption text for xylem.	10 min.	Whole class or in pairs	Learning guide, p. 17, Document it: "Water circulation through plants" diagram (*optional*: with captions hidden)
Introducing the experiment on water capillarity.	5 min.	Whole class	

(continued)



(Continued) Session 3c

Session focus	*Timeframe*	*Organization*	*What you will need*
Experiment on water capillarity: Gently pour a teaspoon of water in a pool in the plate – guide students to notice that water stays together in a pool, rather than flattening out. Then put a paper or cardboard tube in it.	10–15 min.	In pairs	Paper (or cardstock) tube; water; plates *Note:* this is often done with paper towels, but students' attention might be misled by towels' absorption capacity (vs capillarity).
Summing up (water pushed up xylem "tubes" by capillarity)***:*** writing captions on diagram.	10 min.	Whole class	Experiment notebook

SESSION 4: CONCLUSION, FINDINGS

Students must focus on the initial question, use results from their notebooks, and end the session with a clear written summary (possibly put together collectively). They must understand that the conclusion derives from evidence and reasoning, not from the most popular or best argued opinion. They should come out of the lesson with the clear idea that forests redistribute water and are therefore fundamental for human life.

Session 4 : **Conclusion, findings.** Process reminder. Document study. Result analysis, expanding to forests. Lesson. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Recalling the process – from question to results: Guide to question: "How does water then go into the air?"	5 min.	Whole class; student presentation possible	Experiment notebook
Studying documents; optional: filling missing caption text for stomata and root hair. Discuss meaning.	10–15 min.	Whole class or in pairs	Learning guide, pp. 16–17, Document it: "Water cycle" and "Water circulation through plants" diagram (*optional:* with captions hidden)
Analysing results: expanding to forests; brainstorm about how this is important. If Session 1 produced posters, display them: how could they be grouped/organized? Keep questioning until students notice that foliage variable is key.	15 min.	Whole class	Experiment notebook *Optional:* Class poster from Module 1 "What is a forest?" p. 1; Group posters from Session 1 of the present module (plants water intake totals)
Writing of lesson/findings put together collectively (alternately read/glue copy in notebook) the conclusion. Make sure the summary: • mentions that little water is conserved by trees; • generalizes about the value of forests as brought up by students during brainstorming, e.g. drinking-water, climatic cooling effect of rain... (note that these benefits will be reinforced by the work done in the next two sessions).	10 min.	Whole class	Notebook; *Optional:* Learning guide, p. 1, What did we learn?

SESSION 5: WATER AND SOILS DOCUMENT STUDY

Session 5: **Water and soils document study.** *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question: "Are trees useful for water in other ways?" Introducing documents and explaining task...	10 min.	Whole class	Experiment notebook
Studying documents and answering questions.	15 min.	Whole class or in pairs	Learning guide, pp. 20–21, Document it – Water and soil diagrams
Writing/gluing summary of findings: trees are key to protect us when facing meteorological hazards (water supply too high or too low).	10 min.	Whole class	Notebook

SESSION 6: WATER QUALITY DOCUMENT STUDY

These documents provide a basic introduction to the role of trees with relation to water and soils. The aim here is for students to understand some of the main functions of forest soils, e.g. that forest soils filter water because they are porous and capture particles that are suspended in water; and that they are self-cleaning filters because new soil is continuously created.

Session 6: **Water quality document study.** *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Giving the question: "Are trees useful for water in other ways?" Introducing documents and explaining task...	5 min.	Whole class	Experiment notebook
Studying the document (diagram) and answering questions.	15 min.	Whole class or in pairs	Learning guide, p. 22, Investigate – Water filtration diagram
Writing up summary of findings: Trees are key in that they allow us to have drinking water.	10 min.	Whole class	Notebook

SESSION 7: WHAT DO WE DO NOW? FORESTS ARE OURS

Session 7: **What do we do now? Forests are ours.** Knowledge reminder. Brainstorm. Action design. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Recall findings and importance of trees and forests. Ask class if they would like to take action to help save forests.	10 min.	Whole class	Class posters, experiment notebook
Action choice, brainstorming. Guide students towards acting in interaction with local environment and actors.	15 min.	Whole class or in groups	*Optional:* notebook
Action design: Writing how the action will be undertaken, when... ***Implementing action:*** Post-module, based on the action chosen in class. Timing, equipment etc. to be adapted to local context.	20 min.	In groups or pairs	Notebook

VII. Teaching extensions, in addition to the present module on forests

Physical characteristics of water (for example, there are three stages of water); water cycle; photosynthesis; other aspects of plant biology; units of measure; soils; contamination and other topics related to sustainable development.

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MODULE 3

What can we take from forests?

I. Summary

In this module, students will explore a variety of products that originate from forests.[1] They will learn about foods and medicinal resources, as well as latex from rubber trees and other plant products. They will also explore aspects such as the responsible use of forests and the need for regulation of the marketing, selling and buying of goods from forested land. The module includes class and optional outdoors activities.

II. Subject areas, objectives

- Science, language, geography, interpersonal skills and citizenship.
- Cognitive learning outcomes: chronological overview (Ancient Greece, Renaissance to seventeenth century discoveries), world map familiarity (different forest products found in temperate and tropical areas).
- Methodological learning outcomes: ideas and evidence, grouping and classifying products, reasoning and critical thinking.
- Social/interpersonal development: collaboration, applying knowledge to action for sustainable development.

III. Teaching plan

Session 0 *(optional)*:	**Preparatory work.** Forest visit and/or planting of seedlings and/or requesting students to gather food from the forest, and/or literature study of food eaten in prehistoric times.
Session 1:	**Forest products poster.** Displaying labels/images of forest products as students find them in class and at home, on world map if relevant. Over a week or longer.
Session 1b *(optional)*:	**Taxonomy of forest samples.** Introductory activity. Clustering. Filling in taxonomic table. Summary. *45 min.*
Session 2:	**Honey.** Introduction. Document study. Questions. Summary. *30 min.*
Session 3:	**Are forests universal food providers?** Brainstorm about forest foods. Focus on insects. Conclusions. *45 min.*
Preparation of Session 4 *(homework)*:	Plants and/or forest products that can impact human health. Family research. *40 min.*
Session 4:	**Can forest plants be used as medicine?** Question recap. Experiment (antioxidant effect of lemon juice on fruits and/or natural vs pharmaceutical antibiotics and bacteria culture). Discussion. Document study. Conclusions. *45–50 min.*

(continued)

[1] While wood and timber are essential products provided by forests and woodlands, the present module focuses on the non-wood products that can be collected or harvested from them. Timber and wood will be discussed in a forthcoming module.

(Continued) Teaching plan	
Session 5:	**Latex.** Introduction, hypothesis. Document study. Optional local plant rubber ball-making. Conclusions. *45 min.*
Session 5b *(optional)*:	**Study and/or visit and/or making of local forest products.** E.g. natural dye, food preparation (tea, jam, etc.), weaving, decoration (pine cone frames, home fragrances, etc.).
Session 6:	**Responsible forest use.** Introduction. Debate preparation. Discussion. Conclusions. *30 min.*
Session 7:	**Conclusions.** Question recap. Final summary. Final creation. *45 min.*
Session 8:	**What do we do now?** Learning review. Brainstorm. Choice of action to be taken. *30 min.*
Implementing action:	Post-module, based on the action chosen in class.

IV. Possible student misconceptions

Students may have trouble with geographical locations or lack knowledge regarding medicinal discoveries. If possible, use a world map and a historical timeline to help them grasp the context. The present module can also be a good follow-up or introduction to world history (e.g. Renaissance explorations).

Student misconceptions	*Possible answers (experiments they could imagine and are worth testing; other ways to answer)*
Forests only produce wood.	Complete present module.
Non-wood products are limited to fruit and/or edible fungi.	Complete present module.
Many food items we consume regularly are not connected to nature/forests.	Complete present module.
Plants cannot be a source of "real" medicine.	Session 4 and preparation (p. 31).
Rubber is similar to plastic, made from chemicals.	Session 5 (p. 31).
Forest products can be collected and/or consumed without limits or regulation.	Complete present module and especially Session 6 (p. 32).

V. Background and focus on key issues

ISSUE 1: THERE ARE SEVERAL TYPES OF NON-WOOD FOREST PRODUCTS, SO CHOICES MUST BE MADE IN THE SCOPE OF STUDY

These include:

- food products (e.g. nuts, fruits, fungi, bamboo shoots and heart of palm, birds' nests and eggs, oils, sweet sap, roots, tubers, seeds, aromatic plants);
- spices and condiments;
- plant oils (e.g. neem oil, jojoba oil, argan oil);
- oleoresins (e.g. pine oleoresin, bought in shops under a variety of commercial names such as turpentine);
- plant gums (e.g. gum arabic);
- latex (e.g. natural rubber);
- natural pigments and dyes;
- fibres and flosses (e.g. bamboo, raffia, cork, baobab bark);
- insect products (e.g. honey, silk);
- incense wood;
- essential oils;
- plant insecticides;
- medicines;
- animals and animal products (e.g. live animals hunted for their meat, ivory, bones, feathers).

The present module focuses mainly on two types of products:

- fruit, which is familiar to students around the world and yet often subject to misconceptions. The role of fruit in plant reproduction should also be considered in the context of its responsible and regulated use;
- medicinal plants, which are currently used locally in many parts of the world but could potentially have broader uses.

ISSUE 2: INTERCONNECTING USE AND SCIENCE: THE EXAMPLE OF MEDICINE

Botanical knowledge has traditionally been closely connected to medicine. However, with the discovery, at the end of the seventeenth century, that plants also have reproductive organs, modern-day biology was born. The present module focuses on the history and development of two medicines that are still widely used today: quinine and aspirin. Either one or both will likely be familiar to most students and their families.

In the seventeenth century, quinine was found to be an effective treatment for malaria. Quinine is a white alkaloid derived from the bark of the South American quinine tree, or the cinchona (quina-quina), *Cinchona officinalis*. Two legends surround its discovery: a South American legend tells of a man lost in a jungle with a high fever, who accidentally cured himself by drinking from a bitter tasting-pool of stagnant water that was surrounded by quina-quina trees; whereas a European legend involves the Countess of Chinchon returning to Spain from Peru with the powerful bark in her possession, thereby introducing quinine to Europe. The Swedish botanist Carl Linnaeus allegedly called the tree "Cinchona" in her honour, and the medicine is said to have cured the British King Charles II of malaria. Initially, the bark of the cinchona tree was dried, ground to a powder and mixed with liquid before use. In 1820, quinine was extracted from the bark and its purified form became the standard. Synthetic quinine was created in 1944.

The discovery of aspirin is a prime example of collaboration between scientists. In the fifth century B.C. the Greek physician Hippocrates first wrote about willow tree bark and leaves which relieved pain and fevers. It is also said that Native Americans chewed the bark and leaves of willow trees, or used them ground up in a powder. Though first derived from the bark of the willow tree, the active metabolite of aspirin – salicylic acid – is also found in other plants such as jasmine, beans and clover. In the eighteenth century a clergyman named Edward Stone also noted the effects of salicylic acid and during the nineteenth century researchers across Europe studied it further. They discovered that a chemical process known as acetylation could diminish the irritant effects of salicylic acid, and in the 1890s a German chemical and pharmaceutical company developed a patent for acetylsalicylic acid under the name of aspirin. Though taking Aspirin can be dangerous for persons who suffer from some medical conditions (such as bleeding disorders), the drug has proved extremely successful and is still used widely. Today aspirin is produced synthetically and recent research has shown that, beyond reducing pain and fever, aspirin can also play a role in preventing heart attacks and some types of cancer.

Today there is a renewed and growing interest in the use of medicinal plants. Pharmaceutical companies are known to organize bioprospecting expeditions to forests around the world to gather information on plants and how local people use them, a practice referred to by opponents as "biopiracy", in situations in which such action does not follow established rules. Today, the use of chemical plant compounds and traditional knowledge is regulated to ensure that possible profits also benefit countries of origin and holders of traditional knowledge. Bioprospecting is regulated by the Nagoya Protocol on Access and Benefit Sharing (see https://www.cbd.int/abs/).

ISSUE 3: NATURAL RUBBER LATEX

The peoples of Central and South America traditionally used rubber from the rubber tree, *Hevea* spp., which grows in tropical forests, to produce clothing material and rubber balls (according to archaeological evidence, these balls were used for games and in religious ceremonies in Mesoamerica). In the 1700s, French scientist Charles de la Condamine visited South America and sent back samples of *Hevea* rubber to Europe. Modern-day methods of processing rubber were patented early in the nineteenth century by Charles Macintosh of the United Kingdom, who made raincoats from it.

Here are a few key definitions:

- *Natural latex:* a milky fluid found in some angiosperm (flowering) plants. This compound is usually exuded following a tissue injury. The fluid protects the injured tissue against herbivorous insects thanks to its clotting and toxic properties. It can contain alkaloids, terpenes, resins, phenols, proteins, sugars, and long-chain hydrocarbons. The fluid coagulates upon exposure to air, and some latexes are elastic;
- *Natural rubber latex:* comes from the *Hevea brasiliensis* tree, which produces rubber (latex) with high resistance to tearing and greater resilience than most synthetic products. The species is native to South America, and is also widely grown in plantations in Southeast Asia and West Africa;
- *Latex:* tiny polymer particles suspended in a liquid medium;
- *Sap:* aqueous fluid carrying nutrients through the plant; maple syrup and other products are made from edible sap.

In ancient Mexico, the Aztecs used gum from the tree species *Manilcara* spp. to produce a type of chewing gum. Note that nowadays most chewing gum is no longer made from natural rubber latex.

VI. Notes on pedagogical approach and class animation

1. SAFETY AND ORGANIZATION TIPS

The present module involves the handling of potentially allergenic natural products. **Students with allergies to these compounds should therefore not carry out these experiments.** Here are a few preventive measures to help ensure safety:

- *Fruits:* during dissection students should not touch their eyes and must wash their hands and wear protective gloves.
- *Flowers:* pollen can be allergenic. Flowers should be kept in plastic protection before and after dissection.
- *Latex:* latex allergies can be severe, and students with such allergies should not touch any latex products.

2. TEACHING APPROACH

Among the many products that can be collected from forests, the present module focuses on those that are expected to stimulate students' interest, thereby reinforcing the learning process (for example, fruits, medicinal plants and rubber/latex). As noted earlier, this module does not deal with wood, which is the most well-known forest product. The module also has a strong methodological focus, with the aim of helping students to understand that forests need to be approached from several angles if they are to be sustainable.

Finally, the module includes a debate session (Session 6, p. 32): it is likely that many students will spontaneously choose the "protect nature" side, without necessarily being able to build arguments in support of their choice. Dividing the class into two groups and assigning each one a stance (as opposed to allowing students to choose for themselves) may lead to a richer debate both for and against.

3. NOTES FOR ANIMATING EACH SESSION

SESSION 0 *(OPTIONAL)*: PREPARATORY WORK

Teacher preparation of optional local forest product activities in Session 5b (see below, p. 32) as well as possible outdoors visits or activities (see Module 1. What is a forest? and specifically Safety and organization tips in Section VI [p. 3] for guidance on preparing outdoors visits).

Preparing students:

- Forest visit: taking students to "collect" (mostly using pictures) anything they think could be of use for people (material possibly collected by students during Module 1, What is a forest? Session 2, Outdoors visit, p. 3] will be re-used for this module);
- Sowing forest tree seeds (see Module 1, What is a forest? Session 2b (optional): Sowing tree seeds, p. 6) or seeds of fast-growing plants;
- Requesting that students identify food from the forest in their home kitchens, and if possible bring it to the class; checking in advance what they plan to bring in, whether it is relevant and, if possible, finding an unprocessed version or a picture of it for Session 1 below;
- Study prehistoric humans and their food. Ask students what the word "foraging" means to them and if they know foraging is still practised (including new trends such as "urban foraging").

SESSION 1: FOREST PRODUCTS POSTER

Session 1: **Forest products poster.** Displaying labels/images of forest products as students find them in class and at home, if possible on world map. *Over a week or longer.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introducing module question: What can we take from the forest? Name "forest goods".	5–10 min	Whole class	
Start a class poster of non-wood products that come from the forest, adding a picture or mention each time one is identified in class or at home (possibly on world map with original location). Always label product by use, but also by other criteria (e.g. colour, scientific information). Note the different names that people may use for the same product.	One to two weeks	Whole class	Poster, if possible world map poster Glue for product labels and/or images

SESSION 1B *(OPTIONAL)*: TAXONOMY OF FOREST SAMPLES

This optional session is aimed at teachers with a more specific background in science or an interest in taxonomy. Activities will help students identify elements using common criteria, differentiating between clusters of products classified by use (forest products are grouped based on how we use them) and clusters classified by geographic location, nutritional benefits, or according to scientific/biological classification. It may be interesting to use this session to question what an insect is, which would in turn feed into Session 3 (see below).

Session 1b *(optional)*: **Taxonomy of forest samples.** Activity introduction. Clustering. Filling in taxonomic table. Summary. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Activity introduction: Trying to organize information on the large amount of forest products found in activity 1.	5 min.	Whole class	
Classifying forest products: Students in pairs receive several forest products. Pairs are asked to classify, sort or order the products. They must name/label clusters. ***Discuss:*** If most groups were performing the same task, why was this? Give definitions. If relevant, discuss the different names that may be used for the same product. Explain that means of use (e.g. culinary) differ from scientific criteria. ***Start again:*** Now some pairs must group scientifically (naming clusters reveals their criteria: move between groups and discuss if these are actually scientific criteria), others by use. ***Sum up.***	15 min.		Forest products brought in by students and/or displayed on class poster Other forest products (possibly pictures): edible hunted animals, insects, honey, eggs, nests, non-poisonous fungi, non-poisonous plant parts (e.g. fruits, leaves, flowers, seeds, twigs, cinnamon sticks, cloves), rocks, etc.

(continued)

(Continued) Session 1b			
Session focus	***Timeframe***	***Organization***	***What you will need***
Introducing and explaining table (with taxonomic criteria). Filling in table.	20 min.	In pairs	Several products, both local and from forests in other areas and of other types. Documentation on each plant sample (for example leaves, roots) A taxonomic table customized to sample. Experiment notebook
Summary: Definition and use of classification (understanding characteristics and history of species categories).	5 min.	Whole class	Experiment notebook

SESSION 2: HONEY

Session 2: **Honey.** Introduction. Document study. Questions. Summary. *30 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question: "What are honey bees useful for?" Introducing documents and explaining task.	5 min.	Whole class	Experiment notebook
Studying document and answering questions	15 min.	Whole class or in pairs	Learning guide, p. 26, Document it – Bees make forest honey
Writing/gluing summary of findings.	10 min.	Whole class	Notebook

SESSION 3: ARE FORESTS UNIVERSAL FOOD PROVIDERS?

Note on insects: Insects are a class of animals that belong to the arthropod group. They have a chitinous exoskeleton, i.e. an external skeleton made of a horny substance that supports and protects the body, a three-part body (head, thorax and abdomen), three pairs of jointed legs, compound eyes and two antennae. The word insect derives from the Latin word *insectum*, meaning "with a notched or divided body", or literally "cut into sections", from the fact that insects' bodies have three parts. Pliny the Elder who lived more than 2000 years ago, created the word, translating the Greek ἔντομος (entomos) or insect (as in "entomology", which was Aristotle's term for this type of animal), also in reference to their "notched" bodies.

Session 3: **Are forests universal food providers?** Brainstorm forest foods. Focus on insects. Conclusion. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Brainstorm: Forest foods (using class poster if available).	10 min.	Whole class	Optional class poster from Session 1, if any
Organize forest products by use: Types of food (see Session 1). ***Discuss:*** Did students include insects as type of food? Why/why not?	10 min.	In pairs	Forest products, see Session 1
Document study: Eating insects (entomophagy). Answering questions.	10 min.	Individual	Learning guide, p. 27, Document it – Eating insects?
Discussion: Do you think many people in the world eat forest products? Are these products all unlimited (introducing the notion of renewable resources)? ***Conclusion:*** Importance of forests as a food source. List many products both local and from around the world.	15 min.	Whole class	Notebook

SESSION 4: PREPARATION (HOMEWORK)

Only conduct activity for products that are harvested in a renewable and regulated way.

Session 4: **Preparation (homework) – Plants and/or forest products that impact health.** Family enquiry. *40 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Students to enquire about forest plants (including infusions) and/or natural products used by family members for health/well-being, cosmetic products and/or food conservation. Do these really have an impact on health? Design an experiment. If possible, bring sample to school.	20 min.	At home (individual)	Experiment notebook
Reviewing products and experiments. Fine-tuning experiment(s) for feasibility.	20 min.	Whole class or groups	Experiment notebook

SESSION 4: CAN FOREST PLANTS BE USED AS MEDICINE?

Session 4: **Can forest plants be used as medicine?** Question review. Experiment (antioxidant effect of lemon juice on fruit and/or natural vs pharmaceutical antibiotic effects on bacteria culture). Discussion. Document study. Conclusion. *45–50 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Question reminder. Experiment presentation, instructions.	5–10 min.	Whole class	Experiment notebook
Basic experiment: Testing the antioxidant effect of lemon/orange juice on fruit. ***More complex experiment:*** Comparing the effect of forest products (e.g. wild garlic, natural cranberry juice) vs antibiotics on bacteria culture. Washing hands and equipment. Writing up findings, drawing experiment diagram. Optional experiment(s) based on class context.	20 min. (with time to let it rest)	In pairs	*Basic:* peeled fruit, lemon and/or orange juice, cups/plates *Further equipment:* garlic, cranberry juice, antibiotics, bacteria cultures, microscope Other – based on class experiment(s) Experiment notebook
Summary of findings ***Document study:*** text on the renewed importance of forest-based medicine prospection. Discuss meaning.	15 min	Individual	Learning guide, p. 28, Document it – Medicine grows in the forests Timeline and world map if possible
Conclusion: What is the potential impact of deforestation (forest loss) or forest degradation on human health? ***Optional:*** Interview a pharmacist, botanist or expert in traditional uses of forest plants, either in person or by telephone/in writing. Optional project: class herbarium.	5 min.	Whole class	Notebook *Optional:* a specialist

SESSION 5: LATEX

Session 5: **Latex.** Introduction, hypothesis. Document study. Optional: local plant rubber ball-making. Conclusion. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
***Introducing** a forest product:* Natural latex from rubber trees List things made with it Students' ideas on how it is made	10 min.	Whole class	Board

(continued)

(Continued) Session 5

Session focus	*Timeframe*	*Organization*	*What you will need*
Document study: Observe picture. What is leaking out of the tree? ***Discussion:*** Definitions (sap vs latex) ***Optional:*** Making a ball from natural latex by stirring the sap in vinegar with a straw (possibly sap from local plants, for example dandelion). Comparing qualities with that of natural rubber.	10 min. 10 min. *optional*	Individual	Learning guide, p. 29, Investigate Rubber: where does it come from? World map *Optional:* local latex-producing plant (dandelion, sunflower, guayule, etc.), vinegar, a straw, cup
Conclusion: Latex from rubber trees is a good example of renewable resources from forests that can provide income for local people.	5 min.	Whole class	Notebook

SESSION 5B *(OPTIONAL)*: STUDY AND/OR VISIT AND/OR MAKING OF LOCAL FOREST PRODUCTS

Only conduct activity for products that are harvested in a renewable and regulated way.

Session 5b *(Optional)*: **Study and/or visit and/or making of local forest products:** e.g. natural dye, food preparation (infusion, jam, etc.), weaving, decoration (home fragrances, etc.)

Session focus	*Timeframe*	*Organization*	*What you will need*
Based on local context, students will study and possibly visit a production site and help make a forest-based product.	Local context related	Local context related	Local context related

SESSION 6: RESPONSIBLE FOREST SHOPING

Session 6: **Responsible use of forest products.** Introduction. Debate preparation. Discussion. Conclusion. *30 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Optional trigger: Listing human needs and how forests meet them, and/or video on *The Life of a Finn*. ***Question transfer:*** Are forests like a market? Are there enough forest products for everyone? Everywhere? At all times? Task instruction.	10 min.	Whole class	*Optional:* a computer connected to the Internet, with YouTube access and projector
Debate preparation: Half of the students work in pairs dealing with "their" side of the issue, and write down ideas and arguments. • Unlimited" half: Why, when and where can we use forest products without regulations? • "Regulated" half: Why can we not use forest products without regulations? What should be done?	10–15 min.	In pairs	Experiment notebook
Discussion: Students list their arguments. ***Conclusion:*** Need for regulated approach. ***Optional:*** Discuss products that students brought in for activity 1. Are these renewable/authorized/harvested sustainably?	10 min.	Whole class	Poster with two columns: unlimited forest products vs renewable approach. Marker pen

SESSION 7: CONCLUSIONS

Session 7: **Conclusions.** Question reminder. Final summary. Final creation. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Question reminder: What can we take from forests?	5 min.	Whole class	Experiment notebook
Writing and or/reading summary of module findings: balance between use and renewability, etc.	10 min.	Individual	Notebook
Class to create a final product, if possible for communication, such as: • "Magic tree": art/collage or text; students imagine a single tree that provides several products. • "Super forest guessing game"/forest trivia: students write a question on one side of the card, with an answer and illustration on the other (this tree provides a substance that helps cure malaria; this forest insect makes a sweet, edible product and pollinates flowers, etc.).	30 min.	Depending on class choice	Depending on class choice

SESSION 8: WHAT DO WE DO NOW?

Session 8: **What do we do now?** Learning recap. Brainstorm. Action design. *30 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Learning recap (importance of forest products, need for management to ensure renewability, regulation).	10 min.	Whole class	Class posters, experiment notebook
Groups brainstorm action, with a focus on individual behaviour, such as communicating with other children and adults (see art or game created in Session 7); adjusting their harvesting, hunting or shopping behaviours as necessary Students choose individual action(s)	10 min.	Groups of two 2 to 4	Optional: experiment notebook
Action design: How, when, what is needed.	10 min.	In groups or pairs	Notebook
Implementing action: Post-module, based on the action chosen in class.			

VII. Teaching extensions, in addition to the present module on forests

Taxonomy; prehistory; Renaissance explorations (great discoveries).

VIII. Bibliography

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MODULE 4

Whose forest is it?

I. Summary

This module gives students an overview of the benefits of forests and the need to manage them sustainably, on a local and a global scale. It provides an introduction to key aspects of the state of forests worldwide. Through roleplay and joint activities, students will learn about the need to manage and conserve forests in a coordinated and collaborative way. Sessions can be conducted in class as well as outdoors.

II. Subject areas, objectives

- Geography; language; interpersonal skills and citizenship; art.
- Cognitive learning outcomes: world map familiarity; understanding elements of sustainable development, including the importance of collaboration; understanding elements of forestry and forest management.
- Methodological learning outcomes: reasoning and critical thinking.
- Social/interpersonal development: collaboration; applying knowledge to action for sustainable development.

III. Teaching plan

Session 1:	**Designing a "forest of benefits".** Introduction and task definition. Individual design/plan for class art. Discussion and need for collaboration. Collaborative design. Summing up. *45 min.*
Session 2:	**Creating a "forest of benefits" class poster or mural.** Task reminder. Creation of poster/mural. Summing up. *45 min.*
Session 2b *(optional)*:	**Whose forests? Local case study.** Introduction. Document study (map). Hypothesis on current local forest area change. In class or through long-distance interview with an expert, such as an elder or forester. Conclusion. *30 to 90 min.*
Session 3:	**What is the current state of forests worldwide?** Introduction. Document study (excerpts from State of the world's forests). Summing up. *30 min.*
Session 4:	**Story 1 – An orange-growing company in the forest.** Introduction. Roleplay session (writing stakeholders' views; listening; decision; role of animals and plants). Discussion and game. Conclusion. *45 min.*

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(Continued) Teaching plan	
Session 5:	**Story 2 – Small farmer needs grazing land.** Introduction. Roleplay session (writing stakeholders' views; listening; decision; expert's view). Discussion and games. Conclusion. *45 min.*
Session 6:	**Story 3 – Would you choose an amusement park or the forest?** Introduction. Local story debate. Debate composition. Summing up. *45 min.*
Session 7:	**The big picture.** Introduction. Document study (policy action). Responsibilities and possible action. Written conclusions. *45 min.*
Session 8:	**What do we do now?** Introduction. Brainstorm. Action design. *45 min.*
Implementing action:	post-module, based on the action chosen in class.

IV. Possible student misconceptions

Students may have trouble locating geographical areas. If possible, use a world map to help them grasp the context. Present module can also be a good follow-up or introduction to geographical work about climate regions, agriculture, etc.

Student misconceptions	*Possible answers (experiments they could imagine and are worth testing; other ways to answer)*
Forest area change is the same everywhere.	Session 3 of present module.
Indigenous peoples living in forests have the same needs everywhere (and students may not think of forests as places where people actually live).	Session 4 of present module.
Conserving forests simply means letting them grow untouched and unmanaged.	Sessions 3 to 6 of present module.
Decision-making is only in the hands of specific people (for example land owners or policy-makers).	Complete present module.

V. Background and focus on key issues

Students may have trouble locating geographical areas. If possible, use a world map to help them grasp the context. The present module can also be a good follow-up or introduction to geographical work about climate regions, agriculture, etc.

ISSUE 1: A VIEW OF THE CURRENT STATE OF THE WORLD'S FORESTS

Forests and trees support sustainable agriculture through their key roles in the water cycle, soil conservation, carbon sequestration and habitat protection, including for pollinators. Not only do they increase agricultural productivity, but hundreds of millions of people rely on them for food, energy and income.

On the other hand, agriculture is the major driver of deforestation globally: there was a net forest loss of approximately 7 million hectares per year in tropical countries from 2000 to 2010, while agricultural land increased by about 6 million hectares. Deforestation is now greatest in regions with tropical climates, whereas net forest area has increased in temperate regions in recent years. In the tropics and subtropics, it is estimated that large-scale commercial agriculture accounts for 40 percent of deforestation, local subsistence agriculture accounts for 33 percent, and urban expansion, infrastructure and mining account for 27 percent. Yet the situation varies geographically: commercial agriculture accounts for almost 70 percent of deforestation in Latin America. In the Amazon region of Latin America, a major cause of deforestation is cattle ranching. Soybean farming and oil-palm plantations have also been major drivers of deforestation since the 1990s in various parts of the world.

Global forest area declined by just under 130 million hectares (about 3 percent) in the period from 1990 to 2015 and is now just less than 4 billion hectares. Although the rate of global net forest loss slowed from an average of about 7.3 million hectares per year in the 1990s to about 3.3 million hectares per year from 2010 to 2015, deforestation is still a major concern.

Sustainable management is needed to ensure that forests can meet present and future environmental, economic, and social needs, and variables that impact their future must be taken into careful consideration. Decision-makers and society at large recognize that natural resources are neither infinite nor indestructible, and serious commitments have already been made. Seventeen Sustainable Development Goals (SDGs) were adopted by world leaders in September 2015 at a historic United Nations Summit. Over the next fifteen years, countries will apply what is known as the 2030 Agenda to mobilize efforts to end all forms of poverty, fight inequalities, tackle climate change, and ensure the wise and sustainable use of natural resources (see www.un.org/sustainabledevelopment/sustainable-development-goals/).

ISSUE 2: THE COMPLEXITY OF ACTORS IMPACTS ON HOW WE MANAGE OUR FORESTS

Different stakeholders make different demands on forests: while we all need the clean water and air they help to provide, some people also rely on them for energy, food and shelter, while others expect forests to fulfil their recreational and cultural or religious needs.

Various decision-makers are also involved, and national, agricultural, forest and land policies are often at odds with each other. Locally, different types of owners with different goals will all want to have a say. These include individual private owners, local/regional governments, national government, forest industries and private corporations.

Coordination is therefore key to sustainably managing forests. FAO recommendations for policy action include:

- managing forests and agricultural landscapes together to ensure food security, through a sustainable and productive approach;
- creating integrated land-use plans that are designed in a participatory manner;
- establishing clear legal frameworks, such as land-tenure systems that recognize traditional customary rights to forests;
- regulating land-use change where large-scale commercial agriculture prevails, encouraging certification, etc.;
- promoting agricultural intensification, rural development and social protection to ensure food security (as opposed to expanding agricultural areas at the expense of forests).

ISSUE 3: UNDERSTANDING THE MANAGEMENT OF FORESTS AT FORESTRY LEVEL

When discussing forest management, students may spontaneously think only of protection and conservation techniques, such as establishing protected areas or reserves that are largely off-limits to humans, collecting and storing seeds and other reproductive materials in seed banks, and assessing potential environmental impacts when making plans to build on and manage land.

However, biodiversity is just one of a number of components in the sustainable management of forests, which involves making sure that the forest's multiple uses are identified and safeguarded before it is too late. This requires an integrated approach that takes into account all of the forest's environmental, economic and social uses.

Forestry practices will vary according to goals, such as promoting, conserving or altering the area. Practices may include favouring natural regeneration of the forest or of given tree species, tree planting , tending and thinning trees, removing exotic species which are considered to harm native flora and fauna, monitoring and ensuring the conservation of endangered plant and animal species, harvesting of wood and non-wood forest products, controlled burning to promote regeneration or to lessen the risks of future damaging, uncontrolled wildfires, researching the best ways to manage the land for stated purposes and use, etc. Such techniques may appear "un-natural", but they are often necessary – even apparently "natural" ecosystems are already impacted by human activities.

VI. Notes on pedagogical approach and class animation

1. ORGANIZATION TIPS

This module does not include scientific activities per se. Forests are complex ecosystems that can be understood scientifically, and studying them requires transdisciplinary approaches. One reason for this is that they are a component of the human use of landscapes, and as such are connected to disciplines such as geography, economics, politics and policies, etc.

Very concretely:

- The present module can be conducted as part of the following subjects: citizenship education, geography, language and possibly even art for Sessions 1 and 2. If teaching in a school context where different teachers are responsible for different subjects, collaboration and joint classes might help ensure a better quality of teaching.
- If using the same experiment notebook for this module as the one used for previous modules, you may wish to emphasize the different nature of the activities you will now be carrying out, for example by flipping the notebook around and using it from the back, using a different colour code, etc. Or you could simply use another notebook altogether.

2. TEACHING APPROACH

This module uses mostly group work and collaborative approaches. The benefit of working in groups in class has been extensively documented, and a collaborative approach is relevant to the contents of the present module. If your class is not used to group work, you may want to pay special attention to the following elements:

- Imposed groups where the teacher has ensured ahead of time that there is a mix of skills in the group tend to result in better learning results than those where students choose their own groups based on friendships. Students must understand the activity is about the learning goals and not how they feel about individual group members. Teachers should observe the different groups, listening rather than participating. They should however watch out for possible group 'drifting' (for example the exclusion of a student, one student doing all the work or imposing his/her views, etc.) and, if needed, intervene with a question or suggestion to steer the group back on track.
- Assigning roles within groups (leader, spokesperson, secretary, time-keeper, etc.) can help ensure that everyone is integrated into the group work, but can also interfere with content quality as students may focus more on their role than on the overall group task. You could consider assigning roles only if members of the groups do not appear to be working well together. Maintaining the same role over several sessions will allow students to develop specific skills, but rotating them will allow all students to try out different roles. Students who have a hard time working in groups may prefer working in pairs.
- High-performing students may consider group work to be a waste of time. If necessary, refocus on the content of the present module, showing how collaboration can sometimes be the only way for a group (class, society) to reach common goals, such as forest conservation or sustainable forest management.

3. NOTES FOR ANIMATING EACH SESSION

SESSION 1. DESIGNING A "FOREST OF BENEFITS"

This session aims to introduce the idea of the need for collaboration in forest management, but also allows time for reviewing essential lessons learned in previous modules about why forests are so important for people and life on earth. If few or no modules have been undertaken before, the teacher will need to provide students with a list of forests' uses, such as the provision of clean water, clean air, food, habitat, shelter, energy, health and social benefits, and recreational and spiritual values.

If the necessary equipment is available, students can watch FAO's video on "State of the World's Forests 2016: Forests and agriculture – land use challenges and

opportunities" (www.youtube.com/watch?v=jyu_nFiMBb4&feature=youtu.be) or the YouTube video *The Life of a Finn* to help them reflect on the importance and many benefits of forests (see the reference section below).

One way to guide the "forest of benefits" design is for each group to have a general "needs domain", and within each group each student is assigned a specific benefit or forest product. For example the "air" group could have, "this tree gives oxygen, this tree stores carbon dioxide"; the "water" group could have, "the roots of this tree filter water, its fallen leaves keep the soil damp", etc. The same would be true for "food" and "recreation" groups, for example "a bush provides fruit, wood from a tree can be made into skateboards", etc.

Session 1: **Designing a "forest of benefits".** Introduction and task definition. Individual design/plan. Discussion and need for collaboration. Collaborative design. Summing up. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction and task definition: Students will make a "forest of benefits" in class. This will consist of a poster/art work/mural, where each tree or forest component represents a forest benefit or product. ***Task definition:*** Explain the change in the use of notebook (this is not a scientific activity).	5–10 min.	Whole class	
Students individually: • Make a general design for the forest poster: write/sketch what the forest of benefits will be like. What material will they use, colour or not, etc. • Choose which benefit and forest component they will each add to the class forest. The teacher goes from one student to another to get an idea of the different/opposing approaches.	10 min.	Individual	Notebook (experiment notebook flipped, different colour, different notebook, etc.)
Discussion: • The teacher asks several students, one after another, to explain the meaning behind the poster's design. The teacher tries to follow the explanations, and shows when they are not compatible. • Can we design our forests like that? Why/ why not? Need for discussion. • Task definition for new collaborative design method. Make sure that as many forest benefits as possible are covered (using notebook from previous modules if already completed).	10 min.	Whole class	Types of material students may come up with: large sheet of paper, white or coloured, markers, glue, magazine with forest pictures, etc. Experiment notebook A poster listing forest benefits
Collaborative design: • Student groups discuss and make a plan for the design of a forest poster. A group reporter explains their design to the class. • Class decision (for example a vote).	15 min.	In groups of 3 to 4 people, based on similarity of their initial individual designs	Notebook
Summing up	5 min.	Whole class	

SESSION 2: CREATING A "FOREST OF BENEFITS" CLASS POSTER OR MURAL

Session 2: **Creating a "forest of benefits" class poster or mural.** Task reminder. Creation of poster/mural. Summing up. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Task reminder	5–10 min.	Whole class	
Class creates poster/mural based on plan designed in Session 1.	35 min.	Whole class then individual work	Material as decided per design plan in Session 1
Summing up: Reminder of importance of collaboration to create the desired forest.	5 min.	Whole class	

SESSION 2B *(OPTIONAL)*: WHOSE FORESTS? LOCAL CASE STUDY

Session 2b *(optional)*: **Whose forests? Local case study.** Introduction. Document study (plant map). Hypothesis on current local forest area change. In class or through long-distance interview with expert (elder, forester, etc.). Conclusion. *30 to 90 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction of question and task definition	5–10 min.	Whole class	
Study of land and plant maps: Who owns what? ***Optional:*** Percentage of types of ownership. Comparing forest area and area dedicated to other land uses (agricultural land, urban developments, non-forest ecosystems, etc.). Discussion, corrections.	20 min.	Individual or in pairs	Local map and copies of plant map(s) Notebook
Hypothesis on current and past trends/evolution (succession) of forests locally	5 min.	Whole class	
Long-distance or in-class interview of local forester or forest history expert. ***Conclusion and comparison*** of local trends versus world situation analysed in Session 2.	30 min. to an hour	Whole class (individual or in pairs if writing questions for long-distance interview)	A local history expert: elder, forestry officer, etc.

SESSION 3: WHAT IS THE CURRENT STATE OF FORESTS WORLDWIDE?

Session 3: **What is the current state of forests worldwide?** Introduction. Document study (State of the World's Forests excerpts). Summing up. *30 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction of question and task definition.	5–10 min.	Whole class	
Document study: Answering questions.	10 min.	Individual work	Learning guide, pp. 32–33 World map
Discussion of meanings. Summing up. Writing conclusions.	15 min.	Whole class	Notebook

SESSION 4: STORY 1 – AN ORANGE-GROWING COMPANY IN THE FOREST

During roleplay, students must stay in character.

The teacher can introduce roleplay variables, such as: different groups are encouraged to take action together; the orange-growing company learns that dealing with activists and the press is endangering its expected benefits; groups are encouraged to take action regardless of the orange company's decision, etc.

Session 4: **Story 1 – An orange-growing company in the forest.** Introduction. Roleplay session (writing stakeholders' views; hearing; decision; role of animals and plants). Discussion and game. Conclusion. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction: • Trigger: each student is assigned a certain number of trees (one-third of the class are individuals and take one tree for their needs, one-third are small-scale farmers and take two each, one-third are big companies and take three each). What happens? The need to manage. • Introducing the roleplay game to understand how we can manage changes to forests. (Teacher) story reading. Task definition.	5–10 min.	Whole class	A room where students can move around easily. A table that does not have enough "trees" (where trees are represented by pencils, matches, etc.) Story 1, see Learning guide, p. 34

(continued)

(Continued) Session 4

Session focus	*Timeframe*	*Organization*	*What you will need*
Roleplay game, oranges in the forest story: • Students' stakeholder groups choose a spokesperson, decide group's position on project and write group argument(s). "Animal" and "plant" groups instead prepare a way to show the impact of the project on them (poster, mime/sketch, etc.). • Hearing of the stakeholders by the company (decision-makers). • Decision. • The animal and plant group present the consequences for them and for human life. Does it impact the decision?	15–20 min.	In groups of 3–4, then whole class	Story and role descriptions See Learning guide, pp. 34–35
Discussion: • Do you agree with your character's view? Game to allow students to express a difference of view with their characters: students choose sides according to whether or not they agree with the roleplay decision. They move if they agree with other solutions, one after the other (e.g. company abandons project entirely, decides to collaborate with a local cooperative; activists block the project location). After each move, one or two students can explain where they have chosen to stand. Do other students change sides after hearing their reasoning? • Focus on indigenous peoples: Millions of people call the forest "home". Have any other indigenous peoples been displaced throughout history? Why? What happened to them?	10 min.	Whole class	Notebook
Summing up	5–10 min.	Whole class *Optional:* individual	Notebook

SESSION 5: STORY 2 – SMALL FARMERS NEED GRAZING LAND

During roleplay, students must remain in character.

The teacher can repeat the roleplay session, introducing variables such as there is only one forest landowner at first, while in a variable there are two with different goals, etc.

Session 5: **Story 2 – Small farmer needs grazing land.** Introduction. Roleplay session (writing stakeholders' views; hearing; decision; scientist or expert). Discussion and games. Conclusion. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction: New roleplay game to understand how we can manage forest change. (Teacher) story reading. How does it differ from the last story? Task definition.	5–10 min.	Whole class	A room where students can move about easily. Story 2, see Learning guide, p. 36
Roleplay game, farmer grazing story: • Students' stakeholder groups choose a spokesperson, decide group's position on project and write group argument(s). Animal and plant groups choose a scientist as spokesperson and prepare a fact sheet. • Hearing of the stakeholders by the village council. • Decision by vote of the whole community. • Scientist presents the consequences for animal, plants and human life. Does it affect the decision?	15–20 min.	In groups of 3 to 4 then whole class	Story and role descriptions See Learning guide, pp. 36–37

(continued)

(Continued) Session 5			
Session focus	***Timeframe***	***Organization***	***What you will need***
Discussion: Do you agree with your character's view? Game to allow students to express difference of view compared to their assigned characters: students choose sides according to whether or not they agree with the roleplay decision; they then move if they agree with other solutions, one after the other. For example: if the wood from this forest is not harvested or otherwise managed, a wildfire that would endanger the nearby village will probably break out sooner or later; by removing cattle and managing walking trails, the forest could attract tourists; if trained in beekeeping, the farmer could harvest honey from bees in the forest or make soap with the beeswax, selling these products at a good price; the farmer could establish a small, profitable forestry company by planting fast-growing native or introduced trees, yet still keep a few cattle grazing under the shade of the trees; with proper training he/she could grow rice intensively; he/she could plant fruit trees and feed the family, as well as sell some produce, etc. After each move, one or two students can justify where they stand. Does this inspire other students to change sides?	5–10 min.	Whole class	
Summing up: need for communication and integration of all in decision-making; difficulties of decision-making.	5–10 min.	Whole class *Optional:* individual	Notebook

SESSION 6: STORY 3 – WOULD YOU CHOOSE AN AMUSEMENT PARK OR THE FOREST?

This story can be rewritten so as to be replaced or adapted to a specific local situation describing a project which is creating a dilemma regarding forest use.

Session 6: **Story 3 – Would you choose an amusement park or the forest?** Introduction. Local story debate. Argument writing. Summing up. *45 min.*			
Session focus	***Timeframe***	***Organization***	***What you will need***
Introduction: Last story to understand how we can manage forest change. (Teacher) story reading. How is it different from the first two stories? Task definition.	5–10 min.	Whole class	Story 3, see Learning guide, p. 38
Local story debate: • Half the class is assigned a view: for or against regarding clearing the forest to build an amusement park. • Students work in pairs to write out ideas defending their side's viewpoint. ***Discussion:*** • Summing up arguments. • Brainstorming creative ideas to solve the dilemma.	15 min.	In pairs	Notebook or paper for posters
Debate writing: • Position paper on one of the three stories. *or* • Poster for or against one of the stories.	15 min.	Individual	Notebook and/or poster Papers and marker pens
Summing up	5–10 min.	Whole class	Notebook

SESSION 7: THE BIG PICTURE

Session 7: **The big picture.** Introduction. Document study (policy action). Responsibilities and possible action. Written conclusions. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction: Looking into policies to sustainably manage forests (decision-making at regional and national levels.	5–10 min.	Whole class	
Document study about policy approaches. Answering questions.	10–15 min.	Individual	Learning guide, p. 39
What could they have done? Whose job is it to do what? • Students write possible stakeholder actions for the three stories. They must identify at least one potential action per stakeholder. They can use stories and role cards for inspiration. • *Optional:* Watching videos from the Gambia, Viet Nam and Costa Rica to help them find more ideas. • Discuss writing ideas for each stakeholder on a poster, for example raising money to buy reserve land or fund conservation, investing in planting forests, enacting laws that protect indigenous peoples and/or habitat protection, assessing the impact of projects (social, economic, environmental), volunteering, creating a land management plan, consulting citizens, joining an organization, buying certified/renewable/low-packaging products, boycotting certain products, educating others about forests, getting audited/certified, improving agriculture, etc.	15 min.	Individual or in pairs	Notebook Poster paper and marker pen *Optional:* Videos www.youtube.com/watch?v=jyu_nFiMBb4&feature=youtu.be A computer with internet access and projecting screen World map
Writing conclusions about sustainable forest management.	10–15 min.	Whole class/ individual	Notebook

SESSION 8: WHAT DO WE DO NOW?

This session engages students by structuring their actions, more so than in previous modules (if completed), now that they have a more global vision of stakeholders and the complexity of decision-making. It is possible for older students to go into greater detail and design an advanced action plan in later sessions, using tools and checklists (see for example Audubon's Tools of Engagement in references section, below).

Session 8: **What do we do now?** Introduction. Brainstorm. Action design. *45 min.*

Session focus	*Timeframe*	*Organization*	*What you will need*
Introduction: What do you love most in the forest? How do you take care of it? How easy is it to take care of forests? Need for well thought-out action.	5–10 min.	Whole class	
Brainstorming on what goes into an action plan: Completing the plan and drafting the outlines: • Information/knowledge needed • Stakeholders to engage/partnerships (who/how) • Defining precise project scope and goals (including map, conservation targets, etc.) • Threats and cause of threats • Communication (education, social media, etc.) and audience(s) to receive support from • Potential opponents to be identified • Strategy and action • Overall feasibility	15 min.		

(continued)

(Continued) Session 8			
Session focus	***Timeframe***	***Organization***	***What you will need***
Starting the process of designing action, carrying out research, writing documents, etc.	20 min.	In small groups (for example each group is responsible for one part of the class plan listed above)	Notebook Locally drafted documents to help design the action (for example scientific information on local forests, list of local stakeholders, map, etc.)
Completion of design and implementation of action: Post-module, based on the action chosen in class.			

VII. Teaching extensions, in addition to the present module on forests

Geography: landscapes, agriculture.

VIII. Bibliography

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Glossary

Abiotic: non-living.
Absorption: to absorb is to take in or soak up, e.g. a liquid or heat from sunlight.
Agriculture: the practice of growing crops and raising animals to obtain food, animal feed and other useful products like cloth and fuel. For FAO, agriculture includes fishing, fish farming and forestry.
Annual: yearly.

Bacteria: single-celled micro-organisms that interact with other organisms in many different processes and chemical changes, such as decay.
Biodiversity: the diversity of plant and animal life forms, sometimes measured as the number of existing species in a certain place.
Biome: a geographic area that can be classified according to the plants and animals that live in it.

Capillarity: the action of a liquid in a small passage or tube being raised or lowered. This depends on the attraction between the molecules on the surface of the liquid and those of the solid surface it is touching.
Cohesion: the state or action of staying or sticking together, in particular for molecules of a specific body or substance.

Deforestation: the action or result of removing forest (e.g. by cutting it down) to use the land for something else.
Desertification: the process of becoming desert.

Ecosystem: a community of living things that interact with each other and their physical environment as a system.
Energy: the capacity to produce physical change; for example wood gives out energy when burned, which people can use to cook or heat their houses.
Evaporation: when a liquid turns into a gas (water vapour is an invisible gas).

FAO: the Food and Agriculture Organization of the United Nations. FAO's areas of expertise include food science, nutrition, crops and animal husbandry, soil and water conservation, fisheries and forestry.
Filtration: to pass something (e.g. a liquid, air or light) through a partial barrier (filter) to remove unwanted components.
Food web: a system of interdependent food chains.
Forest: an area of trees that may be planted or natural. FAO defines forests as land with trees higher than 5 m and a canopy cover of at least 10 percent – but not if that land is mainly used for farming or buildings (like a town).
Funding: money provided to pay for something.

Fungus (pl. fungi): an organism that grows in the soil, on dead matter or on other fungi by decomposing organic matter. Mushrooms are the fruits of certain kinds of fungi.

Global, globally: worldwide.

Infiltration: when a fluid passes into or through a substance through tiny openings.

Layers: forest layers are levels that host different living creatures, ranging from the soil to the top of a forest; the main layers are the floor, then the understorey, the canopy (upper parts or crown of the trees), and the emergent layer on top.
Litter: dead plant material, such as leaves, bark, needles, and twigs, that has fallen to the ground and forms a recognizable layer above the soil.

Reforestation: to cover land with forest once more by planting and/or seeding.
Rural development: improving conditions in rural areas (in the countryside) so that people have a better life.

Sapling: young tree.
Seed: the fertilized, ripened ovule of a flowering plant, containing the beginnings of a new plant.
Seedling: very young plant or tree grown from a seed.
Smallholders: people who own a small area of land or forest.
Soil erosion: the wearing away of soil through the action of rain, wind and other natural processes, or by human activity.
Stomata: pores (small openings) found in the epidermis of leaves, stems, and other plant organs, that control the exchange of gases between plants and the air outside.
Sustainable forest management: managing forests in ways that benefit people and the environment, both now and for future generations.

Temperate: the type of climate that can be found between Earth's tropics and its polar regions where the temperatures are relatively moderate and with few extremes in winter and summer.
Tenure: a contract that says who does what; land tenure is the system of rules about who can use what part of the land, for how long and to do what.
Trend: a general tendency or course of change.
Tropics: the areas around the Equator, which have a very warm climate and about 12 hours of daylight throughout the year.
Twig: a thin shoot of a tree or other plant, or a small offshoot from a branch or stem.

Waterlogging: when land becomes soaked because there is too much water for it to absorb or drain away.

Xylem: a type of transport tissue in vascular plants. The basic function of xylem is to transport water from roots to shoots and leaves, but it also transports some nutrients. In addition, it helps to support the structure of the tree.

Students' quiz
Questions and answers

WHAT IS A FOREST?

1. HOW DO YOU KNOW IF SOMETHING IS A FOREST?

❑ If I see trees, it's a forest.
☑ If I see several layers of plants with many tall trees, it's a forest.
❑ If it looks natural, it's a real forest.

Forests are organized in layers, dominated by larger trees. There must be many trees and they must be high enough: FAO says that forests are areas with trees higher than 5 m and a canopy of a certain size (it must cover 10 per cent of the surface). Land that is mainly used for farming or buildings, like a town, doesn't count as forest.

It takes some trees to make a forest, but there's more to a forest than just trees...

Some forests grow and remain relatively untouched, so they may look more natural to you. Other forests are taken care of, managed, for example, to avoid damage from fire or pests – but these forests are just as real as the wild ones.

2. WHEN YOU ARE IN A FOREST THERE ARE RULES TO RESPECT.

☑ True.
❑ False.

Some rules will depend on the forest: Each forest area may have rules about what you can do, and what you can harvest or not. It also depends on the people you go with. For example, your teacher will give you certain rules for a class visit to a forest, but a hunter would give you other rules if you went tracking animals together.

Some rules are the same in all forests. Because forests are systems where every living creature depends on others, do not collect anything without making sure there is enough, now and for the future.

3. WHAT CAN MAKE FORESTS CHANGE?

☑ Human actions and natural causes.
❑ Nothing.

Forests have always been changing, both due to natural causes and, since prehistoric times, due to people. Pests, diseases and wildfires can also bring about change, either naturally or due to human actions.

4. FOR A FOREST TO EXIST, IT TAKES:

❑ Non-living things.
❑ Plants and animals.
☑ Both and more.

Forests are like small worlds or systems, where all living creatures interdepend in food webs: that means plants and animals. Living creatures depend also on non-living things (called abiotic) like sun and water.

And that's not all: a forest hosts other organisms that are not necessarily animals or plants, like bacteria and fungi.

5. ALL FORESTS IN THE WORLD HAVE THE SAME LEVEL OF DIVERSITY.

❑ Yes, if it doesn't have much diversity it's not really a forest.
☑ No, each type of forest will have a different level of diversity, and diversity changes over time.

Each forest will have a different level of diversity depending on the forest type, the climate and more… Events that may or may not be caused by people, such as fires, will also change the mix of species and the numbers of each species.

FORESTS AND WATER

1. WHERE DOES WATER GO WHEN WE WATER PLANTS?

❑ It all evaporates.
☑ Most of it travels through the plant and then returns to the atmosphere.

Water travels through the plant, entering from the roots, and then moving up the xylem and into the air through pores (tiny holes) in the leaves or needles. Water carries with it nutrients that the plant needs and uses to grow, while very little is kept by the plant to "drink" for its own use.

2. WHEN IT COMES TO WATER, BOTH PLANTS AND TREES:

☑ Act similarly because trees are plants.
❑ Are not the same at all: plants give water back to the atmosphere and trees keep it to themselves.

Trees are plants. Like all other plants, they give most of the water that they take in back to the atmosphere.

3. WATER GOES INTO FOREST PLANTS:

❑ Mainly through leaves.
☑ Mainly through roots.

Trees do take in some moisture through their leaves, but mostly through the roots!

4. TREES SEND WATER BACK INTO THE AIR:

☑ Through pores called stomata.
☐ Through their pores called stomach.
☐ Through their xylem.

After entering the plant by the roots, water goes up the xylem and back into the air through pores (tiny holes) in the leaves or needles called stomata.

5. FORESTS AND TREES ALSO PLAY AN IMPORTANT ROLE FOR WATER BECAUSE THEY:

☑ Help filter water, keep soils from eroding, and maintain water levels in soils.
☐ Clean water in their xylem before returning purified water to the atmosphere.

Forests help keep the air fresh and humid, but they also play a lead role in what happens to water when it reaches the ground: Their soil filters it so that it becomes clean for people to use. Tree roots help keep soils in place and regulate water content in the ground.

WHAT CAN WE TAKE FROM FORESTS?

1. WHAT KIND OF THINGS CAN BE FOUND IN A FOREST?

☐ Food.
☐ Medicine.
☑ Food, medicine and other products.

Many things we eat and use come from a forest. This includes food and medicine but also spices, oils, gums and latex, fibres like raffia and bamboo to make mats and baskets, insecticides, and nice-smelling products like incense wood… The list is huge.

2. WHAT IS HONEY?

☐ A mixture of nectar and pollen.
☑ A mixture of nectar and enzymes.

Honey is delicious for humans of course, and it is indeed made with nectar. But when bees mix it with pollen it is not honey. It is only once it has been mixed with enzymes in their honey stomach that it can become honey.

3. AROUND 70 000 PLANT SPECIES ARE USED AS MEDICINE AROUND THE WORLD.

☑ True.
☐ False.

A large part of the medicines of the world come from forests – some come directly from forests, others are imitated in a laboratory (they are synthetized).

4. NATURAL RUBBER LATEX IS:

☐ Plastic made from petrol.
☐ A plant sap.
☑ A fluid produced by the plant to protect itself.

Natural rubber is a thick liquid that is collected from a tree named *Hevea brasiliensis*.

5. CAN WE TAKE ALL THE PRODUCTS WE WANT FROM FORESTS?

❏ Yes.
☑ No.

Forests do give us many products, and it's usually better to use their riches rather than remove the forests to plant and grow something else. But we cannot take unlimited amounts: When harvesting, or hunting, or buying products from a forest, we must make sure they are renewable – that we can take them without risking their disappearance or creating health problems for another living part of the forest.

WHOSE FOREST IS IT?

1. FORESTS ARE IMPORTANT BECAUSE:

❏ There are wild plants and animals in them.
❏ They help fulfil many humans needs.
☑ Both.

What makes forests important is both their diversity of life forms (biodiversity) and how much they can do for people: They give food, wood for construction and tools, energy for fire to cook with or heat, , medicines, and many different products, as well as jobs for the people who help manage them…

2. FOREST AREA IS CHANGING. IT IS:

❏ Decreasing worldwide faster and faster.
☑ Decreasing worldwide, but slower than before, and increasing in some places.

Forest area is decreasing but more slowly than before and not everywhere: forest area has recently increased in temperate parts of the world!

3. MANAGING FORESTS SUSTAINABLY MEANS:

❏ Doing nothing: forests should be left untouched and natural.
☑ Using and taking care of forests so that they stay healthy and we can use them for our different needs now and in the future.

Managing a forest sustainably means that it can be used for many needs over time. It means taking care of it and looking at it as a whole: a place for wildlife and biodiversity, a place that provides clean water, shade and shelter, but also a place for jobs and businesses, and a place for fulfilling people's recreational, spiritual and religious needs…

To do this, foresters do not only apply laws to limit people from collecting the forests' resources, or to protect them against wildfires and pests. They also plant, harvest, tend and thin the forest, and more.

4. ONLY A FEW PEOPLE CAN DECIDE ABOUT THE FUTURE OF OUR FORESTS.

❏ True.
☑ False.

Everyone can act to make sure forests are used in a sustainable way, from politicians, company owners and smallholders, to each person that thinks forests are important and wants to use forest goods now and tomorrow. Farmers in particular can make a big difference, because they can come up with ways to grow food that do not require cutting down trees.

5. WHAT SHOULD WE DO TO MANAGE OUR FORESTS SUSTAINABLY?

- ❏ Have proper laws to help make sure they are not destroyed.
- ❏ Encourage everyone to work together.
- ☑ Both and more.

Making wise decisions about forests is not simple but it is possible. FAO recommends many types of actions: for example having proper laws, or making sure that people from different sectors, like forestry and agriculture, and people who live near or in forests, all work together to conserve them and use them in a sustainable manner. But there's more, like investing money to help people make a living without destroying forests, or helping them to prove that their forest land is their own...

RESULTS

FROM 7 TO 10 CORRECT ANSWERS

You're a beaver!

You know so much about trees, you probably spend all your free time in them. Please tell others about them to share what you know!

FROM 4 TO 6 CORRECT ANSWERS

You're a forest squirrel!

You have learned a lot about forests, and are on your way to knowing them very well. Keep learning, and share what you learn with others!

LESS THAN 3 CORRECT

You're a forest turtle!

There is still much more that you can learn and discover about forests. Take another close look at them to find out more about their awesomeness and share it with others.

Feedback form
How relevant was this teaching material for you and your students?

Your feedback matters to us, and we hope to improve this material thanks to you. Please answer all of the questions below to provide comprehensive feedback. Otherwise, please fill in at least the questions on teaching context and go straight to the free comments at the end.

Your teaching context (* = mandatory)

Age of students:*
.....
Number of students:*
.....

Type of school:*
❏ Primary
❏ Post-primary

Teaching area/specialization:*
❏ Science
❏ Humanities
❏ Transversal (all)
❏ Other (describe):
.....

Country:*.....

City/town: .....

or Rural (e.g. village): .....

Name and contact information: .....

What modules did you teach?

❏ Module 1. What is a forest?
❏ Full module ❏ Only the following sessions (complete with session number/s):
.....

❏ Module 2. Forests and water
❏ Full module ❏ Only the following sessions (complete with session number/s):
.....

❏ Module 3. What can we take from forests?
❏ Full module ❏ Only the following sessions (complete with session number/s):
.....

❏ Module 4. Whose forest is it?
❏ Full module ❏ Only the following sessions (complete with session number/s):
.....

Did the session(s)/module(s) tie in with the curriculum?

❏ Very much ❏ To some extent ❏ Not at all

Did you conduct forest or outdoor sessions?

❏ Yes ❏ No If not, please explain why: .....

.....

Had you ever taken students on a forest trip before?

❏ Yes ❏ No

Did you modify the teaching content?

❏ Yes ❏ No

If yes, please describe changes: .....

.....

Would you consider sharing any materials that you have developed to help improve ours? If so, please attach a copy of your materials to the present form or provide a link.

Did you assess students' learning?

❏ No Why? .....

.....

❏ Yes ❏ Preliminary .....

❏ Formative (ongoing monitoring): Please describe

.....

.....

❏ Summative (final evaluation): Please provide examples of questions or other type of evaluation

If you carried out summative assessment, how well did students perform on average in the area(s) you evaluated?

Cognitive learning: science	*Cognitive learning: humanities*	*Interpersonal skills, citizenship*	*Other (describe)* .....
❏ High	❏ High	❏ High	❏ High
❏ Medium	❏ Medium	❏ Medium	❏ Medium
❏ Low	❏ Low	❏ Low	❏ Low

If relevant, comment on the reasons for the types of results you found:

.....

.....

.....

How did you hear about this teaching material?

❏ School authorities; principal; hierarchy

❏ Internet (please provide link)

.....

.....

❏ Colleagues

❏ Other (please describe)

.....

.....

What made you decide to teach it?

.....

Would you teach it again?

❏ Yes ❏ No If not, please explain why: .....

.....

What could we do to improve this teaching material?

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Other comments

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These teaching materials were prepared by
Elsa Rattoray with input from Pierre-Yves Coat on diagrams
and other scientific aspects.

Graphic design and illustrations: Chiara Caproni, Roma.

This teacher's guide aims to introduce students aged 8–13 to forests, their current state and multiple values, while allowing teachers to meet curricular objectives. The teaching modules focus on defining forests, investigating their role in the water cycle, exploring some of their products and introducing students to sustainable forest management.

The teaching draws inspiration from internationally recognized pedagogical approaches such as the inquiry method. Most of the learning takes place by "doing", in classrooms or under the trees, rather than being paper-based, although reading and writing exercises are also included. The teacher's guide is complemented by a separate learning guide for school students.

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